ENERGY, SUSTAINABILITY AND COMMUNITIES: ASSESSING THE POTENTIAL FOR COMMUNITY ENERGY PLANNING IN BRITISH COLUMBIA

by

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B.Sc. University of Manitoba 1986

RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF NATURAL RESOURCES MANAGEMENT

in the

School of Resource and Environmental Management

Report No. 176

SIMON FRASER UNIVERSITY

November 1995

APPROVAL

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Degree: Master of Natural Resources Management
in the School of Resource and Environmental Management

Report No. 176

Title of Research Project:

Energy, Sustainability and Communities: Assessing the Potential for Community Energy Planning in British Columbia

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Energy, sustainability and Communities: Assessing the Potential for

Community Energy Planning in British Columbia

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Abstract

Analysis of the demand for energy services has traditionally focused on efficiency improvements to buildings and equipment. Yet, energy consumption patterns are also influenced by urban infrastructure characteristics which are largely under the control of municipal government. Community energy planning (CEP) is an integrative process that aims to jointly address energy, sustainability and community planning objectives. It is currently in its infancy as a planning process. To move from the realm of concept to that of practice, it is necessary to answer three questions: what is CEP?; why should we do it?; and how do we do it?

This study develops the concept of CEP into four policy packages designed to influence urban land use planning, transportation management, site and building design, and the use of alternative energy supplies. The "why" of CEP must be answered at two levels: at the community level in order to motivate local action; and at a more aggregate level in order to motivate major policy shifts. In this study, the benefits to communities are demonstrated through a series of four case studies which compare two alternative scenarios of development over a fifteen year time frame. Demonstrating the benefits at a more aggregate level is difficult, given the diversity of communities. By focusing on a single component of CEP, namely urban land use planning, it was possible to develop a heuristic for illustrating the benefits of CEP at the provincial level. The "how" of CEP is also examined at two levels: a conceptual level, to identify major legal, technical, economic and social issues; and a practical level, to develop, through a case study, an understanding of some real-world problems and solutions. As CEP requires the involvement of municipal government in an area not traditionally considered municipal jurisdiction, the specific legal authority for municipal action with respect to CEP is examined.

The results of the study analyses suggest that communities can achieve energy and cost savings of 15 to 30% and energy-related emission reductions of 30 to 45%. Investments in the energy sector tend to produce two to three times more jobs in the local economy in a CEP approach versus a business-as-usual approach. At an aggregate level, land use planning reform alone is estimated to produce carbon dioxide emission reductions of 17% at cost savings of 20%. Savings per tonne of abatement are in excess of $600. These results are relatively insensitive to substantial changes in the underlying assumptions, suggesting that uncertainty is not a significant factor in interpreting the results. The study suggests that the greatest benefits will be realized by bringing very low density urban areas up to more moderate densities through selective redevelopment.

The implications of these results for municipalities and regions, the province, and the energy utilities are presented, along with suggestions for further study.

Acknowledgements

Many people have contributed knowledge, skills and support to this project, including fellow students and faculty at REM, some REM alumni, and planners/managers at various ministries and municipal offices. Special thanks are owed to Alison Bailey and Hao Liu of the Energy Research Group at SFU, the rest of the ERG team, and my supervisory committee.

The financial support of the following agencies is also gratefully acknowledged:

- Natural Science and Engineering Research Council;
- British Columbia Energy Council;
- Canadian Institute of Energy;
- Canadian Federation of University Women.

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Section 1 INTRODUCTION

1.1 Background

1.1.1 Energy in Perspective

Over the past two decades, planning in the energy sector has been influenced by the rising costs of transmission and distribution, the discovery of cost-effective opportunities for increased energy efficiency, and a recognition of the rising costs and the environmental, social and financial risks associated with new large-scale generation facilities. These factors have combined to shift the focus of energy planning from expanding supply to managing demand. To date, the management of demand has focused primarily on efficiency improvements to buildings and equipment. Analysis has been dominated by an aspatial modelling approach. Yet energy consumption patterns are not influenced by equipment choice and building design alone. At a macro level, they are influenced by the spatial characteristics of urban infrastructure. In turn, the spatial characteristics of urban infrastructure have a dramatic impact on urban sustainability. Today there is a growing recognition of the need to expand the traditional energy focus to address the question of how infrastructure impacts energy and sustainability objectives, and how policy might, in the long term, influence the shape and character of urban infrastructure.

1.1.2 Definition of Terms

"Urban infrastructure" refers to the structural elements of the urban environment that facilitate access to goods and services. In this study, the term is used to describe land use planning characteristics (e.g., urban density and land use mix), transportation systems (e.g., facilities such as roadways, transit, and pedestrian and cycling corridors) and energy supply and delivery systems (e.g., production, transmission and distribution facilities). While municipal services (e.g., water supply, sewerage and drainage) may also be considered urban infrastructural services, they are treated separately for the purposes of the energy analyses of this study. In a broader sense, the services and policies related to all of these elements (e.g., land taxation systems, community rideshare programs, financing programs, etc.) can also be considered elements of urban infrastructure.

"Community Energy Planning" (CEP) is an integrative planning process that focuses on energy strategies that can be implemented at the municipal level. What it means is not planning for energy objectives alone, but making the connection among energy, sustainability and community objectives. Most of the components of urban infrastructure are largely under the control of, or strongly influenced by, community planning processes; yet municipalities have never been directly involved in energy planning or policy-making. A comprehensive energy planning process incorporating a consideration of the spatial characteristics of infrastructure requires the involvement of municipal government. Given that communities today face a diversity of objectives (e.g., air quality, traffic management, housing affordability, etc.), CEP targets strategies that meet energy objectives while simultaneously supporting broader community development objectives.

"Energy" in the quantitative analyses of this study will include only energy consumed in the residential, commercial and transportation sectors. The industrial[1] component of energy demand is also significant. The study includes assumptions about interactions with industrial activities, but as a scope limitation, these are not quantified.

"Sustainability" has been defined as the reconciliation of three imperatives: the ecological imperative to remain within the limits of biophysical carrying capacity; the economic imperative to ensure an adequate material standard of living; and the social imperative to allow people to live by their expressed values (Robinson, 1995). In practical terms, this suggests that society needs to reduce the level of resource consumption and waste production per unit of services provided, using strategies that minimize the costs of such reductions, and through decision processes that incorporate the objectives and values of all stakeholders. Sustainability need not be interpreted as a necessarily changeless state[2]. This study will make no attempt to define a state of sustainability; instead, it identifies indicators which suggest whether we are moving toward or away from it. In

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[1] Also includes energy consumed in the provision of services such as water supply, wastewater treatment, etc..

[2] For example, the use of finite resources today (e.g., fossil fuels) may be sustainable at some level of consumption, provided that the ecological imperative is met with respect to waste assimilation, and provided that society is moving toward alternatives in the long term.

quantitative analyses, the total cost to society of energy services is used as an indicator of economic sustainability, and emissions of carbon dioxide and nitrous oxides are used as indicators of environmental (or ecological) sustainability. Employment is used as an indicator of social sustainability, although it is arguably an economic indicator as well. Other important indicators of social sustainability are difficult to measure and are discussed in this study but not quantified. Different stakeholders might attach different weights to each of these indicators, or add additional ones; however, these are selected as most likely to be universally important indicators of sustainability. A "sustainable community" or "sustainable energy system" implies that decision makers have made trade-offs among costs, environmental quality and social attributes that are acceptable to an informed society.

1.1.3 Study Rationale and Objectives

The purpose of this study is to examine the potential for CEP in British Columbia. The study addresses four main questions:

1. What are the strategies that are appropriate for communities to undertake as part of a CEP process?

   CEP is an emerging planning doctrine that draws upon a variety of trends in both the community and energy planning fields. Literature exists on the individual components of CEP, but not on putting these components together to make a "whole". There is a need to better define CEP and to identify and package the full scope of measures and strategies that could be included in a community energy plan.

2. What is the effect of those strategies on economic, environmental and social indicators at the community level?

   Given that CEP requires the involvement of municipal government in an area not traditionally considered municipal jurisdiction, the study must demonstrate how CEP could contribute toward other community objectives such as air quality, affordability and employment. Further, it must examine what types of communities might receive benefits from a CEP approach - are the benefits limited to the larger metropolitan centres or will smaller communities also benefit?

3. What is the effect of CEP on *aggregate* sustainability indicators?

   An understanding of the aggregate effects of CEP is necessary to motivate major shifts in policy. Decision makers need quantitative information on the costs and benefits of proposed strategies to society as a whole. Although it is difficult to extrapolate the results of high-resolution analyses on a few communities to predict macro effects in a heterogeneous world, there is value in developing a method of analysis to make an order-of-magnitude estimate of the aggregate effects of CEP. Once a heuristic is developed, it can be used to extrapolate the results and motivate policy at any level, including provincial, national and international levels of government. In this study, results are estimated at the provincial level.

4. What are the major opportunities and challenges with respect to the implementation of CEP in BC?

   Illustrating the potential benefits of CEP will not be sufficient to ensure its adoption in BC. Institutional, economic and social issues create barriers to implementation. Municipalities do not have clear legal authority with respect to implementing energy planning initiatives. A resolution of these issues is necessary to move CEP from the realm of concept to practice.

1.1.4 Methodology Overview and Report Structure

Section 1.2 is a primer on community energy planning. It outlines the forces of change that have paved the way for community energy planning to emerge as a planning process; it develops a set of principles to guide the planning process; and it identifies some of the major benefits CEP is likely to yield to communities and to energy utilities.

The policy development stage consists of synthesizing the disparate policies, objectives and implementation strategies suggested in the literature into manageable "packages" of policies. Each package consists of a portfolio of measures, broadly applicable to a variety of communities, which collectively address the primary objectives of a community energy plan. The policy packages are outlined in detail in Section 2. This section thus serves as a further definition of CEP.

Section 3 outlines the methodologies and results of two modelling exercises designed to examine the quantitative relationships between policy-driven variables and indicators of environmental, economic and social performance. The first consists of a series of four case studies in which the local effects of the CEP packages are estimated across a range of representative community types. The second focuses on urban infrastructure, and estimates the aggregate effects of changes to land use planning patterns on indicators at the provincial level.

Because the implementation of CEP is not straightforward from either a social or a legal / institutional perspective, Section 4 identifies and discusses some of the major issues in implementation. A case study is presented to illustrate some of the practical barriers and opportunities.

Section 5 summarizes the implications of the study, especially with respect to clarifying the roles of different parties in implementing CEP.

1.2 Community Energy Planning

1.2.1 Rationale for Change

Both energy utilities and the communities they serve currently face significant challenges with respect to long-term planning. Changes in the way each does business are being forced by changes in the economic, technological and regulatory environment, as well as by international commitments and changing public values.

Economic and Technical Developments

From an economic perspective, the two most important drivers of change in the electricity sector are the steady decline of economies of scale in central generating stations, and the rising marginal costs of transmission and distribution relative to generation. Taken together, these two factors create a strong incentive for the industry to move toward smaller scale, decentralized generating technologies located on-site or in close proximity to energy markets (EPRI, 1993). The development of small-scale heating technologies at competitive prices puts similar pressure on the natural gas utilities.

Regulatory Influence

Changes in the regulatory climate are now forcing the energy industry to consider seriously and proactively the social and environmental implications of energy decisions. Further, they are requiring an explicit treatment of risk and uncertainty in planning. At a time when energy demand was growing rapidly and predictably, large scale investments made good economic sense. Now as load growth is generally characterized by smaller projections and surrounded by greater uncertainty, the risk of stranding underutilized capital assets with insufficient markets is real. Recent experience in North America with overinvestment followed by stagnating energy demand has left regulators with a strong preference for investing in energy conservation and small-scale, incremental additions to energy capacity (Jaccard et. al., 1992).

International Commitments

In June 1992, Canada, along with 150 other nations at the United Nations Conference on Environment and Development in Brazil, signed the United Nations' Framework Convention on Climate Change. Under the agreement, which is legally binding on its signatories, 36 industrial nations pledged to return to their 1990 levels of carbon dioxide and other greenhouse gas emissions not controlled under the Montreal Protocol by the year 2000 (UN General Assembly, 1992).

Urban infrastructure is one of the key factors determining the rate of release of carbon dioxide (CO_2). In North American cities, which are generally characterized by urban sprawl and automobile dependence, per capita carbon dioxide emissions are more than 50% higher than their compact, transit-oriented European counterparts (Torrie, 1993). In 1993, the COGGER panel (Canadian Options for Greenhouse Gas Emission Reduction) found that technology substitution, including broader structural change to the urban form and the introduction of new supply technologies, would enable Canada to achieve significant reductions in CO_2 emissions. More research is needed however to quantify this effect (Robinson et. al., 1993).

Community Development and Public Values

With the exception of the oil price shocks of the 1970s and early 1980s, modern North American communities evolved in an era characterized by low and declining real energy prices. This situation, coupled with the availability and affordability of the personal automobile, has resulted in urban forms characterized by low-density and non-contiguous land use patterns (i.e., suburbs). The result is a system of urban infrastructure that is plagued by high costs of construction and servicing, underutilized assets (e.g., water and energy delivery systems, roads, etc.), ineffective systems of public transport, and poor energy efficiency. The impact on urban livability includes diminished air quality, increased traffic congestion, loss of green space and environmental amenities, and rising municipal debt. Further, unlike most other municipal services such as water and sewer, many energy services are provided by provincial, national or international corporations and most are imported from outside the community[3]. This reliance on imported energy means a

[3] This is not universally the case. In some provinces and countries, many municipalities own and operate local gas and electricity distribution utilities. However, in BC there are few such local utilities.

lost opportunity for developing local resources with desirable local economic development effects. Today, growing public concern over the decline in urban livability is driving municipal government toward a new planning paradigm.

1.2.2 Definition and Context

Community energy planning is a concept that has evolved over the past few years under a variety of names. At the utility level, CEP measures represent additional options - both supply side and demand-side options - to be evaluated under the umbrella of utility "integrated resource planning[4]". Integrated resource planning involves ranking each available demand-side program and supply-side option on the basis of unit cost (where unit cost includes operating costs and annualized capital costs[5]). Supply-side and demand-side options are then selected in order of least cost, until demand is fully met, or some other constraint (e.g., investment) is reached.

At the community level, CEP is largely a synthesis of other contemporary community planning doctrines with energy planning doctrines (Figure 1.1). The publication of the California Energy Commission's "Energy-Aware" Planning Guide in early 1994 served as the first major catalyst for adoption of the CEP process into conventional municipal planning[6]. While it is now becoming more widely recognized as energy planning strategy, both at the utility and the community level, CEP is still in its infancy with respect to implementation.

The rationale for CEP stems from the premise that significant improvements in the efficiency of energy use can be achieved by purposely shaping the built environment and designing urban services in consideration of energy production, distribution and use . In turn, communities can further their social, economic and environmental goals by improving energy efficiency and by proactively planning for energy supply facilities.

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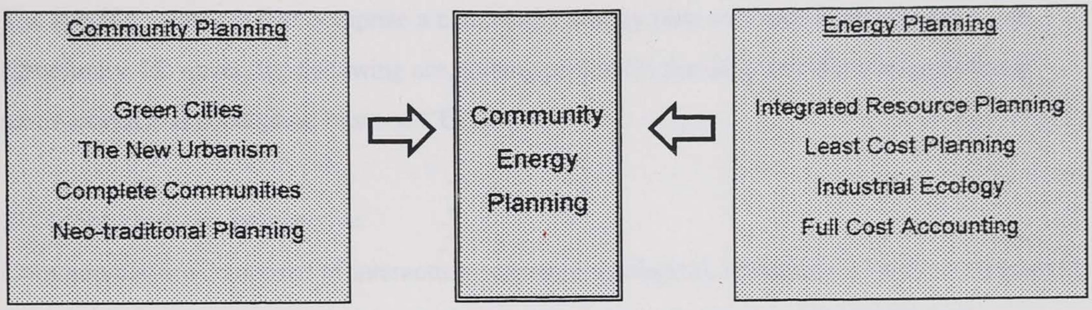
[4] Formerly referred to as least-cost planning.
[5] Where environmental costs are quantifiable and can be converted to a dollar value, these costs may also be included.
[6] In a number of European communities, municipal district heating services have been implemented under the name of community energy planning for many years. However, this is a much narrower definition of community energy planning than that used here.

Figure 1.1 Converging Trends Leading to Community Energy Planning



The strategies that make up community energy planning can be organized into four sectors or “packages”. Each package must be supported by a portfolio of measures designed to collectively meet its specified objectives. The packages and their objectives are:

Land Use Planning:	To reduce the need for travel by improving the accessibility of services through selective increases in density and mixed use; to achieve synergies in land uses, in support of waste heat recovery and optimal infrastructure utilization.
Transportation Management:	To shift the mode of travel away from the single-occupant vehicle and toward transit, cycling, walking, and high-occupancy vehicles (HOVs); and to shift toward alternative vehicle fuels.
Site and Building Design:	To increase the penetration of energy efficient technologies through modified site and building design.
Alternative Supply:	To increase the percentage of energy supplied locally, either through on-site resources, community-based supply systems or waste heat recovery; and to increase the use of environmentally-friendly supply sources.

Specific implementation strategies are outlined in Section 2.

1.2.3 Principles of Community Energy Planning[7]

The specific measures that comprise a community energy plan will vary from community to community. However, the following are guiding principles that help to define the underlying assumptions and conceptual basis of CEP.

1. Adopt a systems perspective.

Communities are composed of interacting economic, ecological, technological and social systems. Planning processes must seek to integrate the objectives and strategies of each through interdisciplinary planning teams and multiple objective decision-making. Energy planners must work together with water and wastewater engineers, land use planners, transportation planners, and telecommunications utilities among others.

2. Focus on energy services, not commodities.

Commodities are what we buy and sell on the market - electricity, natural gas, gasoline. Services are what we feel we need - heat, light, access. By focusing on commodities, the need for energy services is met through the consumption or exploitation of natural resources. By focusing on services, the same services may be delivered through a variety of measures with lower net cost to society. For example, the conventional approach to provision of services is to build additional road capacity to allow people to travel to the location of a desired service. An alternative is to locate services close to residences, effectively reducing the *need* for travel.

3. Adopt a full-cost accounting approach.

Increasingly, communities are faced with planning problems with multiple objectives (e.g., minimize costs, miminize environmental impact, maximize economic development). Decision-makers are required to make trade-offs among them. Full-cost accounting requires that decision makers consider not just the financial cost of the alternatives under consideration, but also their social and environmental effects.

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[7] Adapted from principles developed for a professional extension workshop at the University of British Columbia School of Community and Regional Planning, by T. Berry and L. Failing, November 1994.

4. Look for synergies among multiple objectives.

Many community problems have inter-related causes and solutions. Thus transportation, land use, environmental protection, urban livability and economic development cannot be successfully managed as disconnected issues. To the extent that there are multiple objectives in planning, communities must come to terms with the trade-offs among them, or, alternatively, find ways to avoid the need to trade-off; that is, to find complementary strategies that develop synergy rather than conflict.

5. Look for synergies in the delivery of multiple services.

Exploiting opportunities for joint distribution corridors, joint demand-side management programs, and opportunities for waste heat recovery could reduce overall costs for taxpayers and utility ratepayers.

6. Optimize the use of existing and new infrastructure.

There is no "right" density. Rather, optimum density is likely to depend on a variety of factors and is determined according to the specific opportunities offered by a site. For example, new development can be targeted to areas with underutilized infrastructure, or areas close to the critical thresholds for improved transit service or district heating. Land uses can be mixed to enhance opportunities for waste heat recovery or to take advantage of synergies in the delivery of services.

7. Optimize the use of energy efficient technologies.

Maximizing energy efficiency is not a goal in itself. The optimal level of energy efficiency depends on economic, social and environmental goals and constraints. In general however, increased energy efficiency will lead to reduced energy consumption and, consequently, to reduced air emissions and reduced expenditures on imported products and services. In this way, energy efficiency can be an effective tool for meeting community objectives. The principle of optimizing energy efficiency involves using energy prudently as a means to an end - the end being more livable cities and a more sustainable energy system.

8. Design sustainability into the urban form.

The principle of sustainable urban form has two components. The first is the provision of access by proximity, rather than access by transport. Through well designed increases in density and mixed use, compact communities will help not only to address the negative impacts of urban transportation, but also to improve urban security, housing affordability, social equity, and the quality of neighborhood social interaction - all important aspects of sustainability. The second component is adaptability. Land use patterns, building stock and infrastructure have long life-cycles, while energy prices, technology and social values are constantly changing. Site and building standards can be applied to ensure that buildings can be easily and economically retrofitted for new technologies such as district heating or solar power as these become commercially available.

9. Design sustainability into urban services.

Changes in physical infrastructure will not be sufficient to encourage the changes in individual behavior necessary to achieve sustainability. Concurrent investments are required in the design of services. Improved transit service, community rideshare and employer trip reduction programs, product labelling and building certification standards, retrofit assistance programs, and innovative financing such as "energy efficiency" mortgage terms, are all examples of innovations in urban services designed to improve sustainability.

10. Increase and diversify local energy supplies.

This includes maximizing on-site energy resources, increasing the contribution of community-scale energy resources and expanding the utilization of waste heat. This principle does not advocate total self sufficiency in energy resources, but it does suggest moving down that path. Increased energy self-reliance can have social and economic benefits since dollars spent on external energy sources are not recirculated in the local economy. Further, a diversity of smaller energy resources rather than a few large ones will increase a community's ability to adapt to changing economic conditions and technological opportunities.

Section 2 POLICY DEVELOPMENT

The principles of CEP suggest that the objectives and strategies of each of CEP's four sectors (i.e., land use planning, transportation management, site and building design, and alternative supply) are inter-related. Further, within each sector, overall policy may be comprised of a set of complementary policies which can be interpreted as a "package". Only through implementing packages of related policies will the estimated economic, environmental and social benefits be realized.

Section 2.1 provides an introduction to four generic types of policy instruments that should be considered in developing policy packages: regulatory instruments, market incentives, public investment and information/education. Section 2.2 develops a sample policy package for each sector which contains a mix of instrument types.

2.1 Policy Instruments

Regulation

To date, environmental policy-makers have relied most heavily on regulatory instruments. Regulation encompasses any administrative measure taken by government which has the backing of law, but does not involve either a direct financial incentive or direct government expenditure. Non-compliance with regulations results in judicial action; thus, provided effective enforcement is in place, regulatory measures provide the greatest certainty with respect to meeting policy targets. The *cost* of attainment however, may be unnecessarily high, as regulatory measures do not guarantee economic efficiency.

Regulatory measures at the community level include: zoning by-laws, land use plans, subdivision codes, enforcement of building codes, emission standards, health codes, covenants, etc..

Market Incentives

Market mechanisms use the price system to achieve environmental targets. Most marchet mechanisms can be understood as a way of "internalizing the externalities" of environmental damage. Externalities are barriers to efficient functioning of the market that occur because businesses and consumers don't pay the full costs of the goods and services they consume. By increasing the cost of goods and services to reflect the full cost to society (e.g., through taxes, price increases, emission fees, etc.), business and consumer behaviour can be influenced. Lack of access to capital is another type of market barrier that can be alleviated by market incentives (e.g., low-interest loans for investment in preferred equipment/technologies).

While it may be politically important to make some of these measures revenue-neutral, others may generate revenue for local government. What happens to this revenue is important. In some cases it may be returned to the sector of the economy that paid it. In this case it is both a disincentive to an undesirable behaviour/technology, and an incentive to invest in researching more desirable ones. Alternatively, revenues could be earmarked for specific initiatives related to community development goals (see Public Investment below) or other social objectives.

Market instruments available at the community level include preferential taxation, strategic pricing policies, tolls, development cost charges, transfer of development rights, emission fees, low-interest loans and other financing schemes.

Public Investment

Public ownership has been widely accepted (at least until recently) for many essential services and general infrastructure (e.g., water supply, sewerage, transportation infrastructure, etc.). Changes in these types of infrastructure will often require direct government action and investment. Local government may use investment decisions to make strategic choices about community development goals. When a community chooses to invest in roads versus transit infrastructure for example, the decision will dramatically impact the community's long-term energy consumption patterns, as well as other urban livability indicators such as air quality, traffic congestion, and social equity. Other examples could include investments in green space, public housing, and municipal facilities. In many cases, large-scale changes in municipal investment will only be practical with financing and/or matching funds from the provincial government.

Education/Information

Because businesses and consumers are often ignorant of the negative social impacts of their choices or ignorant of the availability of cost-effective alternatives, the provision of information is another policy instrument that may be effective in bringing about change. Where cost-effective "environmental" alternatives exist, regulation or economic incentives may be unnecessary. Better knowledge of new technologies or management methods and changes in attitude may be sufficient to change the purchasing or management behaviour of businesses and individuals.

Information tools under local control include the provision of billing information, product labelling, building environmental certification, demonstration projects, "green" energy awards for better businesses, technology transfer initiatives, etc.. In general, information instruments will be most effective when used in conjunction with other instruments rather than on their own (Jacobs, 1993).

Which to Use?

Those who support regulation generally argue that there is too much uncertainty around the attainment of policy targets with the use of market measures only. Those who support market measures argue that regulatory measures represent too great of an intervention in markets, resulting in inefficient measures. For political reasons, managing agencies often rely on information and government expenditure, as these avoid many of the conflicts associated with regulation or market measures. The reality is that all these tools are political interventions designed to influence the behaviour of businesses and consumers, either by structuring the availability of infrastructure and services, by removing barriers to effective functioning of the market, or by setting an environmental "bottom line".

The choice of instrument may be in part a function of who the decision maker is. Some aspects of infrastructure (e.g., zoning or transit service) are largely public decisions, and are most often influenced primarily by regulation and public investment. However, infrastructure is also shaped by many private decisions (e.g., developers' proposals for subdivision design, consumer choice of housing type) which can also be influenced by market incentives and better information (e.g., development cost charges, community marketing). Further, investment decisions by local government may be influenced by the availability of capital from other levels of government in support of preferred technologies or development patterns (e.g., provincial grants for developing greenspace in compact communities, financing for community energy systems, etc.). Decisions about buildings and technologies are largely private decisions, and may be more responsive to information, regulatory and market instruments.

Beyond this, there is no particular reason why any one type of tool should be favored by policy-makers over another. The choice between them should be made on how well they meet the objectives set. A full discussion of the criteria for determining the effectiveness of policy is beyond the scope of this study. However, the message of this abbreviated discussion is that each of the types of policy instruments discussed has a role to play in helping a community reach its economic, environmental and social goals. An over-reliance on any one is unlikely to result in effective policy-making.

2.2 Policy Packages

This section outlines the rationale, objectives and expected benefits of each package. A list of suggested implementation strategies is also included. However, there are a broad number of possible strategies and these are not the only nor even necessarily the best for every community. Local planners will be best positioned to select those among them (and among others listed in more detailed sources[8]) that are most suitable to local conditions and priorities.

[8] See references noted with * in the Bibliography.

2.2.1 Land Use Planning

> ***Goal: Access by Proximity***
> ***Synergies in Land Use***
>
> - *Establish a strict urban boundary to prevent sprawl and protect green space.*
> - *Target strategic locations, both new and existing, for high density, mixed use, transit-oriented development.*
> - *Incorporate a mix of housing types that includes single and multi-family dwelling types in balanced proportions.*
> - *Locate heat sources next to heat sinks.*

Community energy planning promotes an approach to urban planning commonly referred to as the "urban village" or "complete community". The main principles involve urban densification and increased mixed use development with the objective of providing "access by proximity". Access by proximity means bringing homes, jobs, schools, services and shopping closer together into more compact and more complete communities, effectively reducing the *need* for travel.

Anderson (1993) summarized the work of a number of land use models showing transportation energy savings ranging from 20% for relatively minor changes to a base case urban form to 80% for "most-efficient" urban design. There is a strong body of empirical evidence[9] to suggest that a doubling of density may result in a 25-30% decrease in vehicle kilometers travelled (VKT). The greatest improvements will result by targeting low density areas of urban sprawl and increasing the average density up to more moderate levels through selected and focused densification and mixing of land use, especially along transit routes (Holtzclaw, 1993).

The work of Holtzclaw (1991) and of Newman and Kenworthy (1989) support the notion that a switch point exists somewhere around 30 people per hectare of overall urban density, across which VKT reductions may be dramatic. Holtzclaw indicates that further savings are possible on top of these through improvements in transit service; however, others (California Air Resources Board,

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[9] Holtzclaw's (1991) findings in a San Francisco study are confirmed by studies conducted by independent researchers in Toronto, New York, Chicago, Manhattan, and a selection of United Kingdom cities (Holtzclaw, 1993).

1993; Newman and Kenworthy, 1989) suggest that the 30% reduction includes the effect of improved transit. A conservative approach suggests that reductions in the order of 25-30% are achievable in the overall metropolitan region. This will not be achieved in a uniform fashion. In certain neighborhoods, *site* reductions in the order of 50-80% are achievable.

Benefits

By reducing the need for travel, three direct effects on transportation energy are realized. Increased density improves the economics of transit sufficiently to allow improved service and consequent modal shift; increased mix and density reduces the distance travelled which in turn reduces the energy required for conventional auto travel; and the reduced distance allows a modal shift to walking and cycling to occur. Reduced traffic results in improved air quality, reduced traffic congestion and noise, and potentially fewer accidents. Lower gasoline consumption leads to lower emissions of nitrous oxides and carbon dioxide which are locally and globally significant pollutants respectively.

Increased density may result in an increased tax base within urban boundaries. Further, with more people on the street walking and cycling in an urban village environment, street crime may be discouraged, translating into greater urban security. The shift to multi-family housing and secondary suites increases the availability of more affordable housing and the integration of people from a variety of social backgrounds.

Municipal savings are realized due to decreased expenditures on road infrastructure and maintenance, water and waste water pumping, waste collection, improvements in the economics of mass transit, and reduced costs of servicing new lots. Frank (1989) estimates savings on lot servicing costs (including streets, storm drainage, water distribution and sanitary sewer) of roughly 30% for compact neighborhood design versus conventional design. Further, studies suggest that the capital and operating costs of services such as fire, police, ambulance, and waste disposal decrease on a per capita basis with increasing density (Urban Development Institute, 1993).

For energy utilities, higher density development and greater mixed use may also lead to cost savings as a result of improving asset utilization through better load characteristics.

Implementation Strategies

Local government maintains the primary authority and responsibility for implementation of land use planning measures. In some cases as noted, partnership with energy utilities will be preferred. The following are some sample measures:

- Offer density and height bonuses to developers in areas targeted for intensification, especially near transit facilities.
- Allow transfer of development rights[10] to encourage densification of targeted areas.
- Establish a revenue-neutral differential taxation structure which taxes land heavily relative to buildings and makes it expensive to leave land vacant in areas targeted for infill.
- Amend the building permit process to require minimum numbers of different housing types.
- Reduce lot sizes by reducing set backs from the street.
- Amend zoning to allow secondary suites.
- Require that all new developments include cycling, pedestrian, and transit access. A "performance point" system may be adopted for flexibility[11].
- Develop a fast-track approval process for developments that meet or exceed guidelines.
- In consultation with energy utility planners, amend the land use plan to identify the most favorable heat source areas (industrial) and designate them as significant resource sites requiring special development standards for future uses. Locate heat intensive uses close to heat sources wherever practical.

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[10] Transfer of development rights can be used to preserve existing lower density uses and increase densities in targeted areas. When the allowable density on the land is reduced (e.g., to preserve agricultural land etc.), a set of credits can be set up based on the potential use of the land. Developers in the targeted high-density area can buy the credits, which become density bonuses for them (Weissman & Corbett, 1992).

[11] The preferred characteristics of the development are identified, with points allocated to each. Examples include bus shelters, bike paths, reduced street widths, greenspace, passive solar design in buildings, etc.. Development proposals must receive a minimum number of points for approval.

2.2.2 Transportation Management

> ***Goals: Shifting the Mode of Travel***
> ***Shifting to Alternative Fuels***
>
> - *Strictly limit the expansion of single occupancy vehicle (SOV) capacity. Provide increased high occupancy vehicle (HOV) capacity .*
> - *Encourage measures and pricing policies that increase average vehicle occupancy rates .*
> - *Invest in transit, pedestrian and cycling facilities and services to encourage modal shift.*
> - *Encourage fuel switching, especially by fleets.*

While the land use planning measures are intended to reduce the need for travel, the focus of the transportation package is to shift the mode of transport. This is only possible where people are located near to transit facilities and where the urban form is sufficiently compact and sufficiently mixed in its provision of services that non-auto modes of travel can provide people with adequate mobility.

There is little emphasis in this package on measures that improve the flow of traffic or efficiency of vehicles. While these measures may have short-term effects, they do not contribute to long-term systemic changes that promote more sustainable patterns of urban transportation. Some of the measures in the package are based on the principle that pricing, whether for parking, emissions, vehicles or fuel, must reflect the true social cost of driving. While studies indicate that higher prices may not alter behavior significantly in the short term[12], such measures will send the right signals in the marketplace about the impacts of travel choices. More importantly, they also generate revenue that can fund public investment in transit, pedestrian and cycling facilities. In general, the strategy should be to start with the market where it works, mandate change where the market has insufficient leverage, and invest in infrastructural changes that will enable consumers to make informed choices without loss of personal mobility.

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[12] Holtzclaw (1994) found no statistically significant relationship between household income and auto ownership or vehicle miles travelled, suggesting pricing will have little effect on driving patterns. His study examined communities with an income variation of US$28,000 to US$ 119,000.

Based on empirical results in a number of US cities, the California Air Resources Board (1993) suggests that transportation management measures alone can result in savings of 10-15% in vehicle kilometers travelled, and in conjunction with land use planning measures, savings can reach 30% or more.

Benefits

Increased transit ridership improves cost-effectiveness. In British Columbia, where municipalities depend on transit ridership for revenues while costs are shared between municipality and the province, increased ridership dramatically reduces the municipality's share of the transit subsidy. Reduced expenditures on road infrastructure and maintenance as well as reduced fuel costs of municipal fleet vehicles allow funding of cycling and pedestrian facilities. Revenue collected from parking fees and road or bridge tolls can finance other initiatives.

Implementation Strategies

The following strategies can be implemented by local government, but would be made easier by cooperation at the provincial level, in terms of providing planning/analysis, financing and enabling legislation.

- Require that all businesses employing 50 or more employees institute an Employee Trip Reduction Program, which may include carpooling services, subsidized transit passes or cash options in place of parking benefits.
- Increase the cost of parking in the downtown area, with sliding pricing rates to encourage HOVs. Restrict new parking additions.
- Provide transit priority traffic signals at congestion locations.
- In cooperation with the provincial managing agency, increase the frequency of transit service, with a more flexible fleet makeup (mini vans, taxi ride-share programs etc.).
- Add cycling lanes, bike racks, wider sidewalks and street trees and furniture in mixed use nodes and along strategic connectors. Offset these costs by reduced expenditures on road maintenance and construction.
- Adopt an aggressive "Go Green" campaign to encourage modal shift.

- Impose tolls at peak hours on key bridges and connector routes.
- Switch all transit and municipal fleet vehicles over to environmentally friendlier fuels in stages.

2.2.3 Site and Building Design

> ***Goals: Increase Energy Efficiency***
> ***Increase Use of Microclimate***
>
> :
>
> - *Increase the penetration rate of energy efficient technologies through programs that increase consumer awareness, improve access to capital and provide technical assistance.*
> - *Encourage the use of microclimate and vegetative cover in new developments*[13] *.*
> - *Preserve solar options for the future by orienting lots, building glazing and roof pitch for maximum solar gain.*
> - *Invest in energy efficiency programs in public buildings.*

The technologies that are currently available to cost-effectively reduce energy consumption in buildings are many and varied, yet the penetration rates of these technologies remain below the achievable potential. The problem lies not with the technical and economic feasibility of energy efficiency improvements - these are well established - but with the removal of market failures that prevent the adoption of economically competitive choices. Failures include inadequate information, poor access to capital, and perceived implementation difficulties. Here municipal government can join utilities in removing the barriers to allow individuals, businesses and the municipal government itself to realize significant savings in annual energy expenditures.

The municipality can play a lead role in the community by adopting energy efficiency initiatives in its own buildings. Local government however, is typically faced with budget limitations and restricted borrowing ability; therefore, the preferred strategy is to arrange third party financing. This is achieved through a turn-key energy service package from an Energy Service Company (ESCo). The ESCo installs the energy efficiency equipment, manages all or part of the energy system of a building in combination with the facility operator, monitors the energy consumption of the building regularly to determine actual energy savings, and arranges the financing for the

[13] Using building design and vegetation/landscaping to provide wind shielding, solar gain, summer cooling through shade trees, etc.

efficiency measures. Performance is guaranteed and the financing is structured so that a portion of the energy savings goes to the ESCo for a predetermined period of time to cover the project costs. Thus, the payback period is extended but the municipality is spared the inconvenience of financing and managing the retrofits, with guaranteed results.

In new buildings, energy requirements can be reduced by 10-40% through the use of passive solar design (CMHC, 1983; CEC, 1993). The use of microclimate and vegetation can further reduce consumption by 5% to 15% (CEC, 1993). The use of street trees and minimization and strategic location of paved areas can reduce cooling requirements. Since commercial space is generally a net producer of heat, the placement of residences above commercial space reduces residential heating demand. These measures are simple and virtually costless, but require cooperation at the broader land use planning level, and are usually overlooked in the planning process. In one US community, for example, a focus on energy efficiency found that reductions in energy consumption of 40-60% could be achieved at only a 2% increase in the up-front capital cost of housing (Criterion et. al., 1994).

Benefits

The participation of municipalities in energy efficiency initiatives will result in a greater penetration rate of cost-effective efficiency alternatives. Studies indicate that municipalities may save from 30-50% of annual energy expenses (Goldberger, 1993) depending on the size and characteristics of municipal buildings. Utilities will realize cost savings as a result of avoiding the costs of new generation, transmission and distribution facilities. Cost savings translate into increased competitiveness and improved customer satisfaction.

Municipalities may use the money from energy savings to finance other community development initiatives from affordable housing to park management. At the community level, money spent on energy services received from the electricity and natural gas grid systems is essentially money leaked from the local economy. Savings in energy bills represent money that can be spent on other goods and services in the community, with a consequent increase in local economic activity. Money spent in typical consumer fashion generates roughly 12-16 jobs per million dollars spent. Because of the nature of these jobs and the types of skills they require, a significant percentage of these jobs are likely to be filled in the local community. This compares to money spent on large energy supply projects which generate only 3.3 jobs per million dollars spent - jobs which are typically located outside the community (Sims, 1991).

Implementation Strategies

In cooperation with energy utilities, municipalities may consider the following measures to increase energy efficiency and use of microclimate:

- Mandate energy efficiency improvements in municipally owned buildings through third party financing and turn-key implementation by an ESCo.
- Adopt a retrofit marketing and financing strategy that targets homes and businesses at time of resale. A community energy audit will establish the concentration areas which likely include improving air tightness, insulation, and the efficiency of heating and cooling systems.
- Work with local financial institutions to develop mortgage terms that recognize the lower operating costs of energy efficient homes[14].
- Require all buildings to be certified for environmental performance.
- Adopt a revenue neutral property tax assessment process to benefit energy efficient buildings and penalize others.
- Establish a revolving fund for energy efficiency improvements by businesses and homeowners. This may be financed by part of the savings from the municipality's own energy efficiency program.
- Expand existing building approval processes to include consideration of the use of microclimate, landscaping, and location of paved surfaces in conjunction with efficiency standards.
- Require that all new buildings in low density single family dwelling developments include solar hot water heaters, passive solar design and design for microclimate.
- Revise the building code to require roof pitches that are optimal for solar photovoltaic application. This will preserve the option to move to technologies which are likely to be cost-effective in the future.

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[14] This measure may also be applied in the land use planning package to take into consideration the reduced travel costs of people living in high density mixed use nodes.

- Require that the plumbing of all new buildings be designed to preserve the option of conversion to solar hot water in the future. The incremental cost of doing so is minimal.
- Provide incentives to encourage the installation of photovoltaic cells in all new construction. If done at the time of roofing, the incremental cost will be reduced.

2.2.4 Alternative Supply

Goal: Increase % Energy Supplied Locally
Increase % Environmentally-friendly Sources

- *Identify opportunities for use of district heating/cooling, heat pumps and distributed generation.*
- *Expand recovery of waste heat in businesses and industries through mixed use strategies and cogeneration projects.*
- *Expand the use of renewables and high-efficiency supply technologies by providing technical assistance and financing mechanisms.*

District energy systems with cogeneration may provide the most promising strategy for many communities to increase the percentage of final energy supplied locally. Conventional power stations use only about 35% of the energy content of the fuel they burn. District energy can utilize up to 85% with cogeneration of heat and power, making far better use of energy resources and reducing emissions. Generally speaking, district energy will be more economic in those areas that have a high building and population density and mixed use with relatively high heating loads. However, with the development of hot water distribution systems in place of steam, distances of over 25 kilometers can be served, and recent studies indicate that the economics of serving moderate density core areas and even lower density suburbs are becoming favorable (Rogner, 1993; MacRae, 1993). With cogeneration of heat and power, the possibility exists for a municipal utility or private energy service company to sell power back to the utility.

District heating systems may be fueled by a variety of sources, including natural gas, wood waste and municipal waste. They may be augmented by industrial heat sources as available. In communities with populations over roughly 50,000 people, biogas from sewage facilities may be used to cogenerate heat and power (Himmler, 1995).

Micro-cogeneration units apply the above principles at the building scale. Natural gas engines achieving efficiencies of over 90% can generate electricity to meet the needs of a given building or complex of buildings, and a collection system utilizes the waste heat given off during generation to meet the building's heat load. By the year 2000, micro-cogeneration may also take the form of natural gas fired fuel cells, which are even smaller and quieter than natural gas engines (Prater, 1995). With agreement from the utility, such units can be tied into the electricity grid system, and the economics of the operation are improved by selling excess power back to the utility. Since commercial buildings are generally otherwise required to install back up diesel power units, the building space needs associated with micro-cogeneration units are not significantly greater.

Heat pumps, particularly in the mild coastal or southern interior climate of BC, are another candidate technology. They are a proven technology that cause little burden to the end user, and improved public information as well as incorporation in municipal building performance criteria are likely to result in substantial increase in penetration. Up to four units of heat output can be achieved per unit electrical input; however, where heat pumps displace natural gas heating, electricity consumption will increase, which may or may not be consistent with local planning objectives.

The implementation of community renewables-based generation plants or individual systems are more problematic as the economics are less proven and the precedents less firmly established. However, the barriers are largely ones of perception and can be influenced through improved information, demonstration, and financing. The possibility of market restructuring in the electricity sector suggests that opportunities for "green consumerism" may emerge (i.e., where consumers elect to purchase their electricity from "green" sources). One strategy links renewables requirements to land use planning strategies; namely, standards that require a minimum adoption of heat pumps, solar hot water heating, photovoltaics, etc. can be set for areas that continue to be zoned for low density single family dwellings.

Benefits

Shifting to alternative energy resources may have significant socio-economic benefits beyond energy and energy-related emissions reductions. Such systems can be designed to use local energy resources that cannot be used for other purposes (e.g. biomass, garbage, industrial waste heat and sewage effluent). At the same time they provide increased protection from energy market fluctuations either through a guaranteed local supply and by keeping energy dollars circulating in the local economy. Improved efficiency and cost-effectiveness also keeps money in the local economy. Additional benefits might include a cleaner environment that makes the community a more desirable place to live, increased employment opportunities that result in improving the local tax base and long-term economic stability, and, in some cases, a solution to the problem of garbage disposal.

This package promotes two basic goals: 1) increasing the utilization of local energy resources, and 2) increasing the use of environmentally-friendly resources. There will be trade-offs between these two goals as some local resources may be more environmentally damaging than some imported ones. For example, a local coal resource may provide local jobs but will have serious implications for air quality objectives, while a remote wind farm provides environmental advantages but potentially fewer direct local jobs. In British Columbia, where local resources will seldom include coal, this is of less importance; however, there will remain a need for explicit trade-offs among competing options.

Local supply options offer energy utilities new business opportunities, savings in transmission and distribution costs, and fewer land use conflicts associated with new transmission corridors. They may also decrease the risks associated with large-scale investments in energy supply facilities. Investments in renewables may keep them abreast of evolving regulatory requirements, improve public relations, and, should market restructuring allow for increased green-consumerism in electricity markets, open up new business opportunities.

Implementation Strategies

There is no predefined target for alternative energy supplies. The optimal level will depend on the availability of cost-effective alternative resources, and the price of demand-side and conventional grid-supplied energy. Working groups of municipal planners, energy utilities, developers and community representatives should work together to develop the following sampling of measures into appropriate community-specific strategies.

- Create a district energy zone which encompasses those neighborhoods considered for ultimate inclusion in a district energy system. Apply special measures for density, diversity, rate of growth and site standards for this zone.
- Establish a combined heat and power plant under the jurisdiction of a municipal utility, which provides district heating services and electricity to the district energy zone, and sells off peak power to the utility. This must be done in conjunction with land use planning practices that increase in stages the density and heat load of the core area.
- Require that all new buildings in the district energy zone contain hook-up infrastructure for future connection to district heating. Discourage electric baseboard heaters and rooftop chillers with development cost charges, preserving the opportunity to move to a district heating system in the future more cost-effectively.
- Set a district energy municipal franchise tax to generate the same revenues to the city as would be lost as a result of district energy displacing gas and electricity.
- Use development cost charges to encourage the use of distributed generation units in commercial development outside the district heating zone.
- Establish a minimum renewables standard for areas that continue to be zoned for low density. Require new single family homes to use solar hot water preheat systems and passive solar design standards. Include the use of preferred technologies as part of a performance point system in other developments.
- Provide financing mechanisms for preferred technologies for homeowners. Establish a revolving fund for these technologies for homeowners, perhaps with part of the municipal energy savings.
- Locate high heat users next to heat sources to make use of waste heat.

2.3 Implementation Considerations

Embedding CEP in Existing Community Plans

Community energy planning need not be a stand-alone process. In fact, for maximum benefit, it should be an integral part of a broader planning process that has been undertaken to address growth and/or other long-term community issues. CEP strategies may be incorporated into official community plans, regional growth management plans, major site (re)developments, transportation plans, air quality plans, or major policy or bylaw review processes. In fact, by embedding CEP strategies in broader community plans, many of the potential barriers to CEP can be overcome (see Section 4.1.1). The risk of embedding is that a piecemeal approach will be adopted, with the result that the expected benefits will not be achieved. Nonetheless, provided that it is well-managed, an embedded CEP program offers communities the opportunity to realize benefits with minimal resource requirements at the planning stage.

The Timing of CEP Strategies

Not all strategies are appropriate for each community, nor is it always appropriate to implement everything at once. If a particular strategy is not appropriate or necessary today, it should be evaluated for its potential future applications. For example, photovoltaics are not universally cost-effective today, but cost projections suggest that, for many applications, they will be within the next decade. However, if we do not design for solar access today - a virtually costless measure - we may find that we have created an urban form that does not easily facilitate solar applications in the future - a costly missed opportunity. Similarly, if we continue to sprawl today, we cannot hope to realize the benefits of district energy systems in the future.

Where strategies can be eased into effect gradually, the transition to more sustainable development patterns may be smoother. Many of the supply technologies proposed in Section 2.2.4 for example are particularly flexible and have the potential for modular incremental additions. The concept of temporal sequencing is also relevant to certain strategies that involve the use of a "stick" approach. Phasing in employee trip reduction programs beginning with employers with over 100 employees and moving down to those with 50, or phasing in parking fee increases over time, will ease public acceptance.

Institutional Partnerships

Table 2.1 summarizes the benefits of CEP to communities and to utilities, suggesting a strong rationale for partnership in implementation. Communities should seek to involve local and provincial energy utilities at an early stage in the development of CEP policies and plans. As expertise in energy planning and analysis is typically lacking at the municipal level, the cooperation and support of the energy utilities can help to fill this gap.

Partnerships with the private sector are also important for successful implementation. Whether a municipality has chosen to emphasize regulations or economic instruments, gaining acceptance and involvement in the CEP process by businesses and developers is critical. Some businesses stand to gain through CEP by expanded business opportunities in energy efficiency activities (e.g., retrofit contractors and equipment suppliers), some by opportunities to participate in new energy supply initiatives (e.g., equipment vendors, construction firms, etc.), and others simply by realizing savings in operating costs resulting from improved energy efficiency. Developers have both something to lose (e.g., established markets in conventional developments) and something to gain (e.g., reduced development costs and new markets). Thus, their participation in the CEP planning process should be particularly encouraged.

Appendix ?

Table 2.1 Benefits from Community Energy Planning

CEP PRINCIPLE	COMMUNITY BENEFITS	UTILITY BENEFITS
Energy Efficiency	. Increase local jobs by keeping money in the local economy and by investing in different types of jobs . Support local business by lowering the cost of doing business . Decrease negative environmental impacts of energy supply and delivery systems	. Avoided costs of new generation, transmission and distribution facilities . Increase competitiveness due to lower costs . Improve customer satisfaction and reduce conflicts over new energy facilities
Sustainable Urban Design	. Improve personal mobility and accessibility of services . Decrease the cost of all linear services (e.g., roads, water, sewers, drainage) . Decrease municipal facility operating costs (e.g., municipal buildings, public facilities, water and sewage treatment, lighting, etc.) . Decrease per capita cost of "response-time" services (e.g., fire, police, ambulance services) . Improve neighborhood character and social interactions . Increase urban security . Improve housing affordability	. Improve utilization of existing distribution infrastructure . Improve cost recovery on new and existing infrastructure . Improve asset utilization through better load characteristics . Increase adaptability of existing building stock to future economic conditions and technological advances . Increase opportunities for joint utility corridors
Alternative Supply	. Diversify local economic base . Increase local employment . Improve global and local environmental performance . Alleviate waste disposal problems . Minimize conflict over new transmission corridors	. Increase business opportunities . Savings in transmission and distribution . Avoid costs of large-scale generating facilities . Minimize land use conflicts associated with new transmission corridors . Decrease risks associated with large-scale investments

Section 3 EVALUATING CEP

Community energy planning represents an addition to the conventional inventory of measures for addressing energy objectives. Policy makers in the energy and the community arenas need to know the costs and potential benefits of the proposed strategies. New analytical tools are needed for evaluating the impacts of new policy options and long-term development plans. Analyses must integrate social, environmental and economic effects to reflect the values and objectives of decision makers at all levels. This section describes the methodology and results of two modelling exercises intended to evaluate the impact of CEP at the local and the aggregate level.

The modelling exercise in Section 3.1 describes a wide range of benefits (e.g., energy savings, costs, emissions, and employment) that result from policy interventions in four different sectors (i.e., land use planning, transportation management, site and building design and alternative supply). These results are reported from the community perspective. That is, costs reported are those incurred by the community rather than by society as a whole.

The potential contribution of CEP is dependent on a wide variety of factors, the most significant of which are climatic conditions, fuel availability, economic / industrial base and urban infrastructure. Of these, the most interesting and significant variable from an energy policy perspective and within the scope of this study is urban infrastructure. (Box 3.1 provides the rationale for this determination.) Thus, the second modelling exercise in Section 3.2 focuses on the cost savings and emission reduction potential of interventions in a single sector - land use planning. Only those measures influenced by land use planning were considered (including, for example, housing type, availability of waste heat, district heating market share, and transportation modal shares; but not employee trip reduction programs, equipment and building efficiency improvements, etc.). The results are presented from the perspective of society as a whole such that costs include hidden subsidies on road infrastructure and transit.

Box 3.1	Rationale for Selecting Land Use Planning for Further Study
Climate	The effect of climate is usually less significant than other factors such as lifestyle and construction practices. For example, an average household in the coastal community of Surrey actually uses more building energy annually than an average household in the northern climate of Prince George due to larger average square footage and lower standards of air tightness.
Fuel Availability	The availability of electricity and natural gas are clearly constraints on energy supply opportunities in some communities, and a community energy planning approach may have particularly significant benefits for these communities. However, these communities represent a relatively small percentage of the BC population, and, for the purposes of an aggregation exercise, can be excluded.
Economic / Industrial Base	The economic/industrial base of a community affects trip generation characteristics and thus opportunities for transportation energy savings. However, there are few if any BC-specific studies providing data in a detailed enough format for further study. The industrial base of a community also affects opportunities for cogeneration and the utilization of waste heat, however as a scope limitation, this study has largely excluded the industrial sector.

3.1 Estimating Local Effects

The purpose of this modelling exercise is to identify the effects of community energy planning on the local environment and economy in four communities representative of the types of communities found in British Columbia.

3.1.1 Methodology

Overview

The study compares the results of two alternative scenarios of technological and structural evolution - a "business-as-usual" (BAU) scenario in which current trends are extrapolated fifteen years into the future, and a "community energy planning" (CEP) scenario in which it is assumed that the community successfully adopts the principles and strategies outlined in the proposed policy packages over the same time period.

Four communities were selected to represent the range of community types in British Columbia. Three of the communities cover a cross-section of community sizes (e.g., population), types (e.g., metropolitan centre, resource community, regional service centre) and geographical locations/climates. The fourth represents a type of community referred to as "non-integrated"; that is, connected to neither the electricity grid nor natural gas system. Although they represent a very small percentage of communities in BC, non-integrated communities are significant from an energy perspective in that the costs of servicing them are very high, and energy service limitations are perceived as a constraint to local economic development.

In each community, research involved the review and analysis of relevant documentation including: official community plans and other long range planning documents, zoning maps, transportation patterns, housing and population data, utility data on electricity and gas consumption, infrastructure costs, and transit cost and ridership information. BAU and CEP trends were developed through interviews with long range planners and municipal engineers.

Scenario Development

Data was collected in each community to provide a baseline estimate of residential dwellings (number and type), commercial floorspace, total number of commuter and casual vehicle trips, and average trip length. Where data was unavailable for commercial space, provincial average data was used on a per capita basis. Heat and electricity load data were derived from Marbek (1993) for commercial space and different housing types. In the absence of site-specific trip generation data, total number of trips was based on number of commuters (Statistics Canada, 1991) and an estimation of the average number of daily trips per household (BCEC, 1994).

To develop the BAU scenario for urban form, planners were asked where most residential and commercial growth was likely to occur in the coming fifteen year period. Average trip distance was estimated using the weighted average distance from population centres to the nearest mixed use node. Housing type mix was based on recent trends and projections for the future. The CEP scenario was developed by asking planners to identify the most plausible area(s) for redevelopment and intensification, and potential locations where single family residential developments could be located near central facilities. Population distribution was manipulated until the CEP land use plan achieved the following targets:

- Accommodate 30% of residential growth in nodal areas, entirely in apartments and multi-family dwellings;
- Accommodate the remaining 70% of growth in contiguous development;
- Accommodate overall growth in equal proportions of single family dwellings to apartments and multi-family dwellings;
- Accommodate 50% of all new commercial development in mixed use nodal areas, especially those that represent large single heat loads.

Transportation management measures were assumed to increase average vehicle occupancy and to induce a shift from SOV to transit, pedestrian and HOV modes. The value of the change varied by community type (see Appendix A3).

The energy savings due to conventional DSM in the BAU scenario is based on ISTUM[15] simulations which indicate that, in the absence of any policy interventions, an overall reduction in base energy intensity of 15% can be expected as a result of natural technology evolution. The CEP scenario assumes that through implementation of the policy packages, municipalities are successful in removing barriers to greater penetration, such that reductions in base energy intensity can be increased to 30%. Thirty percent represents half of the economic potential as reported by the Conservation Potential Review (CPR) Phase I study (Marbek, 1993), and confirmed as achievable by the CPR Phase II study findings (SRC, 1994), suggesting that it is a conservative figure.

With respect to energy resources, the BAU scenario assumes that energy continues to be provided primarily through the electricity grid and natural gas mains, in shares equal to those in 1994. The CEP scenario assumes that a variety of local and imported supply options are available, including a broader range of demand-side management initiatives.

Appendix A contains: (A1) a more detailed description of the methodology; (A2) a description of the case study communities, the customized CEP measures and an overview of results; (A3) the performance targets assumed and the summary model output; and (A4) a "how-to" guide for communities to estimate their own potential savings.

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[15] Intra-Sectoral Technology Use Model: An energy end-use model developed at Simon Fraser University that simulates consumer response to price and technology evolution.

Simulation

A spreadsheet model was used to evaluate the impacts of the CEP measures in the year 2010. This is a static model and the results represent annualized rather than cumulative effects. The inputs to the model are variables that affect energy consumption and that can be manipulated by policy instruments. The outputs are energy consumption, carbon dioxide emissions, total energy system costs, and employment indicators. Appendix A3 contains the quantitative correlations assumed in model calculations. The correlations used originate from published data from energy and transportation studies in other communities, but are subjectively scaled for different community types (e.g., small remote communities will be unable to achieve transit ridership comparable to metropolitan centres).

The model contains no competition and no optimization; that is, all energy market shares are estimated and input exogenously given prevailing assumptions about cost and availability. Thus the results cannot be strictly interpreted to represent precisely either economic (i.e., cost-effective) or achievable (i.e., practical) potential. However the emphasis on conservatism in the scenario development stage suggests that the results approach achievable potential.

All costs are calculated based on a life-cycle cost analysis[16] at a real social discount rate of 7%. Estimates of savings are in real dollars (i.e., net of inflation). Employment multipliers are adapted from Sims (1991) and Marbek (1993c). The method of estimating employment effects is summarized in Appendix A, along with a more detailed description of the modelling methodology.

Commercial fleet and freight transport were not considered in the transportation calculations. Thus the transportation savings reported here represent only a portion of expected actual savings.

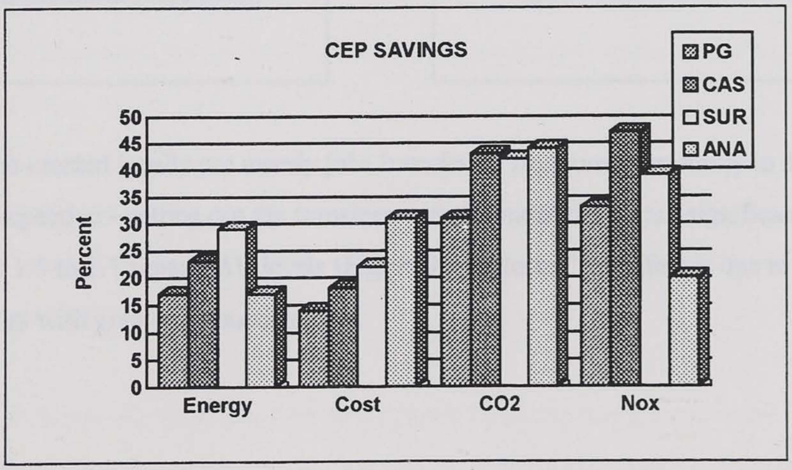
[16] Life-cycle cost analysis involves adding up all the costs associated with an energy supply over its lifetime, including capital costs, operating and maintenance costs and fuel costs.

3.1.2 Results

Results are presented as the savings realized in a community energy planning scenario versus a business-as-usual scenario[17]. In general, the community energy planning scenarios are characterized by a reduction in energy consumption as well as a shift to alternative supply technologies. As a result, significant benefits are realized in all communities. Figure 4.1 shows energy, cost and emissions savings for each of Prince George (PG), Castlegar (CAS), Surrey (SUR) and Anahim Lake (ANA). The figures for Anahim Lake are not directly comparable with the others, as the analysis of that community in this study excluded transportation energy.

In summary, communities may expect energy savings of 15 to 30%, cost savings of 15-30%, and carbon dioxide (CO_2) and nitrous oxide (NOx) reductions of 30-45% as a result of community energy planning. Slightly higher emissions reductions are possible in non-integrated communities that are displacing diesel-powered electricity generation by cleaner alternatives. The savings reported here include those realized through reduced energy consumption and a shift to more cost-effective supply technologies, but exclude those associated with savings in municipal infrastructure (e.g., water, sewers, drainage, curb and gutter, etc.). Savings in municipal operating budgets were only partially identified in this study (see Appendix B), however the literature suggests that savings of 30% or greater in the capital costs of servicing new lots are achievable (Frank, 1989).

Figure 3.1 Savings Realized in CEP Scenario Vs BAU



[17] Business-as-usual by definition is an extrapolation of current trends. It does not imply that municipal or utility planners have not considered any alternative paths for the future.

Figure 3.2 shows that the percentage of energy supplied locally ranged from 20 to 45%, versus nearly zero in the BAU scenario. This contributes to improved conditions for local employment. Figure 3.3 shows that in the CEP scenarios, investments in the energy sector will tend to produce two to three times more jobs in the local economy than in the BAU scenario. In general, the increase is due to three factors:

- investments in local supply, which tend to yield jobs in the local economy, while investments in imported supplies (hydro-electricity and natural gas) tend to yield non-local jobs;
- investments in efficiency, which tend to create more jobs than investments in energy supply;
- savings associated with lower energy bills, which result in a "respending effect" as people respend their savings in the local economy.

Figure 3.2 % Building Energy Supplied Locally

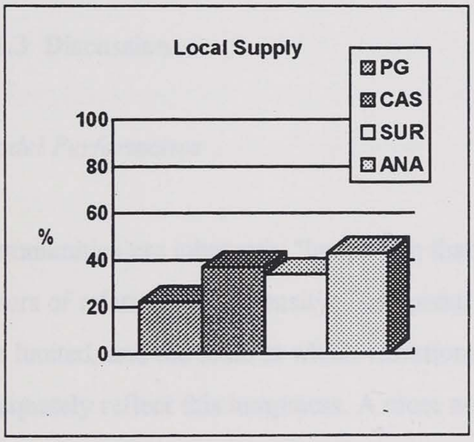
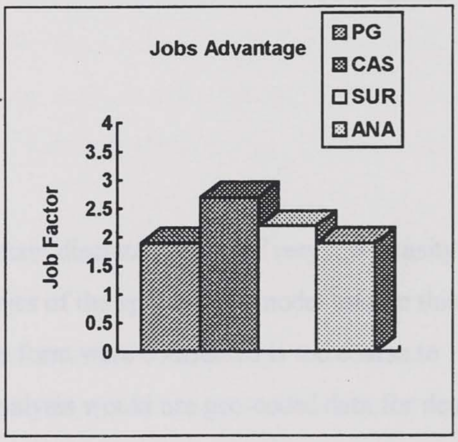
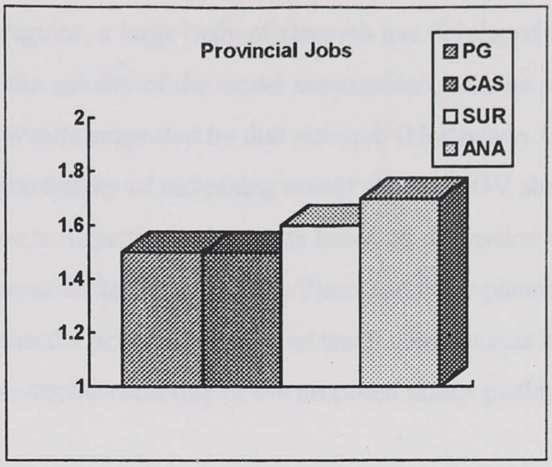


Figure 3.3 CEP Jobs Advantage



Some of the jobs created locally are merely jobs transferred from one community to another. From a provincial perspective - netting out the transfers - employment effects are significantly lower, but still positive, at 1.5 to 1.7 times BAU levels (Figure 3.4). Most of the effect is due to respending of savings in sectors with greater labour intensity.

Figure 3.4 Provincial Jobs Advantage from CEP



Significantly, substantial benefits are realized by all community types, not just the large metropolitan regions of the Lower Mainland. Detailed results are presented in Appendix C.

3.1.3 Discussion

Model Performance

Communities are inherently "lumpy", in that they contain discrete regions of very low density and others of relatively high density. The spatial capabilities of the spreadsheet model used in this study are limited, and the scale at which variations in urban form were considered is too coarse to adequately reflect this lumpiness. A more accurate analysis would use geo-coded data for density, distances, employment distribution, etc..

A second limitation arises from the absence of detailed site-specific data. This resulted in the use of average provincial data, which blurred the distinctions between community types and narrowed the range of achievable benefits.

A third limitation is that the distribution of employment locations was not explicitly considered in the analysis. The implicit assumption is that through an emphasis on mixed use development, municipalities will achieve a well-balanced jobs-to-labour force distribution.

Unfortunately, it is not straightforward to compare the results of this study with those in the literature. In metropolitan regions, a large body of research has developed which allows considerable confidence in the validity of the model assumptions, and the results achieved for Surrey are consistent with results suggested by that research (Holtzclaw, 1993). However in smaller communities, the practicality of increasing transit shares, HOV shares, etc. have yet to be proven. Estimations used were subjective judgements based on discussion with planners, transit officials and review of relevant Official Community Plans and other planning documents. Thus while it can be concluded that the potential benefits in small communities are significant, the degree of uncertainty regarding the implementability of the proposed policy packages is higher.

In spite of its limitations, the model serves two useful purposes: it provides order-of-magnitude results that illustrate divergent trends in the business-as-usual scenario versus community energy planning, and it is flexible enough to model a variety of policy measures, illustrating the diversity of measures that are available. The measures considered are realistic given the existing urban form and development patterns of the case study communities. The results suggest that the majority of communities, regardless of size, location, climate, growth rate or economic/industrial base, are likely to have sufficient energy alternatives available to realize benefits from a CEP approach.

Greenhouse Gas Abatement Cost

The provincial government has established a goal of stabilizing greenhouse gas emissions at 1990 levels by the year 2000. However, without a major change in policy direction, an extrapolation of current trends indicates that emissions in 2000 will rise to levels 20% higher than those in 1990 (BCEC, 1994). Assuming that all communities in BC were to successfully adopt the community energy planning approach outlined in this study, significant progress would be made toward the target. Taking an average of the carbon dioxide reductions in the three communities (excluding Anahim Lake, as non-integrated communities make up less than 1% of the population in the province), and factoring in population growth, overall energy-related greenhouse gas emissions in

2010 will rise by just over 8%[18]. This level of emission reduction could be achieved at a *negative* abatement cost (i.e., savings) of $100 to $115 per tonne.

When costs and emission reduction potentials are disaggregated by transportation and building energy, the following conclusions may have implications for policy with respect to the implementation of CEP in British Columbia:

- Abatement in the transportation sector is achieved at significant savings to society, largely due to the decrease in the need for travel. Savings range from $140 to $230 per tonne of abatement.
- CO_2 abatement in the building sector is achieved at higher cost than abatement in the transportation sector. Abatement cost is still negative, with savings ranging from to $28 to $78 per tonne.

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[18] Where the transportation, commercial and residential sectors contribute to 72% of energy-related greenhouse gas emissions, and assuming carbon dioxide accounts for 90% of energy-related greenhouse gas emissions.

3.2 Estimating Aggregate Effects

The purpose of this modelling exercise is to develop a methodology for estimating the aggregate effects of one component of CEP, namely, community land use planning patterns, at the provincial level.

3.2.1 Methodology

Overview

The study compares the energy-related costs and emissions for two alternative scenarios of development over a fifteen year period: BAU and CEP. Three classes of development are identified, differentiated primarily on the basis of residential density[19]. Box 3.2 defines the three classes. "Density" will be used throughout this section as the primary characteristic defining each class. However, it is understood that increased mixed use and access to transit, pedestrian and cycling facilities accompany density increases.

Box 3.2	**Definition of Development Classes**
Urban Node (Pedestrian - oriented)	Central city or regional city centre Residential density greater than 40 dwelling units per hectare High service job density (service jobs per residential hectare) Wide mix of uses Access to transit, pedestrian and cycling facilities
Compact Neighborhood (Transit - oriented)	Smaller central city or neighborhood within a larger urban area Residential density of 15-40 dwelling units per hectare Moderate mix of uses Moderate access to transit
Sprawl (Auto - oriented)	Suburban area Residential density less than 15 dwelling units per hectare Limited uses; primarily residential Limited access to transit

[19] Density as used here refers to dwelling units per residential hectare, where residential hectares do not include road allowances or park land.

Three categories of energy end-use are considered: space heating, electricity,[20] and transportation. Per capita energy consumption (and consequently energy-related emissions) in each category varies by development class. Further, the use of certain technologies to provide those end-use services has unit costs that vary by development class. This study identifies those technologies that are affected by density considerations, estimates their penetration rates in each development class, and quantifies the extent to which per capita emissions and costs are affected by density. It also estimates per capita consumption by end-use in each class. In order to estimate the percentage of the BC population living in each class, three types of communities (archetypes) are identified. By altering the percentage of the BC population forecast to live in each archetype by 2010 (i.e., a BAU growth projection versus a CEP (higher density) scenario), the long-term energy implications of urban infrastructural characteristics can be estimated.

Penetration rates are represented by an estimation of the market share enjoyed by each technology in each class by the year 2010[21]. After identifying the base unit cost of each technology, "technology cost multipliers" are developed to estimate how those base costs vary with density.

Density-Dependent Technologies

Not all technologies are affected by density. The market share gained by heat pumps for example, and the unit cost of energy delivered by heat pumps are independent of density. Thus heat pumps are not included in this study. On the other hand, while the cost of waste heat does not vary (it is considered "free" energy), the percentage of space heating needs that can be met by waste heat (market share) is dependent on the existence of vertical mixed use structures and the proximity of commercial and light industrial operations to residential zones. The economics of district heating and cogeneration applications are highly dependent on thermal load density and load shape, both of which are influenced by density and use mix.

The density-dependent technologies considered in this study for space heating and electric service are defined in Box 3.3.

[20] Electricity used to provide space heating services is included in space heat.
[21] Assumptions about market share represent realistic "what-if" values rather than rigorous estimates.

Box 3.3	Technology Definition
District Heat	District heating with cogeneration, using combined cycle gas turbines.
Micro-cogeneration	Cogeneration of heat and electricity using natural gas engines, typically at capacities of less than 5 MW.
Waste Heat	Heat which escapes from commercial or light industrial operations and is available for use in residential heating applications (especially via vertical mixed use structures). It is considered a free heat source.
Gas Mains	Conventional natural gas service.
Electricity Grid	Conventional electric service.

With respect to transportation, both consumer choice and economic performance will be affected by urban density and use mix. Transportation modes considered in this study are defined in Box 3.4.

Box 3.4	**Transportation Mode Definition** (from Litman, 1995)
Transit	Diesel bus with an average vehicle occupancy of 12.
Auto	Composite automobile profile composed of 40% average auto, 40% fuel efficient auto, 20% 12-passenger van. Average vehicle occupancy of 1.4 (assumes peak period occupancy of 1.1, non-peak occupancy of 1.5)
HOV Passenger	Passenger in a 12-passenger van. Incremental cost is assumed to be zero (i.e., additional fuel costs are ignored).
Cycle	Average cost bicycle.
Walk	Assumed to be free.

Technology Market Shares

The market share gained by alternative technologies will vary by development class as a result of alternative density characteristics. Market share will also depend on factors other than density - factors such as market barriers (e.g. availability of capital, split incentives (see Section 4.2), lack of information), regulatory arrangements, the existence of local suppliers, and the price of conventional sources of energy. For the purposes of this exercise, however, it is assumed that technologies will be selected for those applications where they are cost-effective from a societal point of view[22], assuming prevailing BC energy prices, an absence of significant market barriers and a supportive regulatory environment.

Technology Base Costs

Each technology is characterized by a base cost which is derived from current documentation or opinion (Table 3.1). Supply technology costs include engineering costs of the equipment installation and operation. Transportation costs include the direct costs associated with vehicle purchase and operation, and the costs associated with the provision of road facilities[23].

Table 3.1 Base Costs and Sources

Technology	Source
Electricity Grid	BC Hydro Rates
Gas Mains	BC Gas Rates
District Heat	Arsenych & Kerr (1993)
Micro-cogeneration	Derived from Inland Pacific Gas estimates
Transportation	Litman (1995)

Table 3.1 Notes

1. Base costs for space heating and electricity technologies are life-cycle costs adjusted for efficiency. That is, calculations are based on end-use consumption multiplied by unit costs, where unit costs are generation costs divided by the efficiency of the generation and transmission system.
2. The use of electricity and gas rates assumes that marginal costs are roughly equal to average costs; i.e., rates (BC Hydro, 1994b; RCG, 1994).
3. Base costs for transportation are life-cycle costs.

Consumption and Technology Cost Multipliers

The extent to which per capita consumption and technology unit costs vary with density is estimated through a variety of methods including past experience, relevant documentation, and the opinion of professionals and researchers working in the field. Box 3.5 summarizes the rationale/sources of these multipliers.

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[22] No formal social cost benefit analysis is performed; the market shares used here are based on the experience of energy analysts familiar with the technologies under consideration. The societal point of view considers total system costs discounted at a rate typically lower than that of the individual consumer.

[23] Vehicle costs include: purchase cost, insurance, registration and taxes, maintenance and repair, fuel, fuel taxes and oil, paid parking and tolls, and other operating costs (transit). Road facility costs include: road construction and maintenance, land acquisition, financing expenses, and the portion of roadway support facilities and programs required for automobile traffic.

Box 3.5	Basis for Technology Cost Multipliers
Electricity & Gas	Preliminary results from INDEX™ [24] studies for BC Hydro.
District Heat	Calculated by holding total heat and electrical demand constant, but halving the thermal density. Does not account for any increase in capacity utilization expected as a result of increased land use mix.
Micro-cogeneration	Assumed to be constant for all neighborhood types as unit costs depend on site characteristics only.
Transportation Modes	Based on consideration of various professional judgements and relevant documentation.
	Basis for Per Capita Consumption Multipliers
Space Heat and Electricity	Assumes *sprawl* is composed of single family homes, *compact* is composed of duplexes and triplexes in conjunction with single family homes, and *node* is composed of one-to-three story apartments in conjunction with duplexes and triplexes. For compact neighborhoods, energy savings of 15% are estimated based on the savings associated with shifting half the housing units from single family homes to duplexes and triplexes. For nodes, energy savings of 25% are estimated based on the savings associated with shifting half the housing units from duplexes to low- and high-rise condominiums (CEC, 1993). Since most of these savings occur as a result of shared walls and floors, It is assumed that energy savings in commercial buildings are proportional to those calculated for residential buildings.
Transportation	Holtzclaw's (1991) review of density studies suggests that VKT is reduced by 30% at each doubling of residential density. As Holtzclaw's findings also suggest that one mile on transit displaces 4-8 miles by automobile, the simplifying assumption used here is that reductions in *passenger* kilometers travelled are proportional to reductions in *vehicle* kilometers travelled.

Scenario Development

Communities in BC are grouped into three archetypes (Box 3.6) based on their initial conditions with respect to density, BAU projections and CEP performance targets (see Appendix B2 for a list of communities in each archetype). With the exception of the GVRD, communities within each regional district are assumed to have similar characteristics. The percentage of the total population estimated to exist in each of the three development classes (Node, Compact and Sprawl) is shown in Table 3.2 for initial conditions. The BAU and CEP columns show the projection for the

[24] INDEX is a GIS-based modelling tool used in a BC Hydro sponsored study of alternative land use plans in Surrey City Centre.

percentage of new growth that will occur in each of the classes for each of the archetypes. These figures represent the percentage of new growth only that is located in each class and does not account for redevelopment effects. That is, some new growth may occur through infill, transforming existing compact neighborhoods into nodes, and existing sprawled areas into more compact neighborhoods. The effect of omitting this effect is to make the estimate of the potential contribution of altered land use patterns to energy indicators more conservative.

Box 3.6	**Characteristics of Community Archetypes**
A	Relatively high density cities which already have a significant nodal area(s) and which have already begun a trend toward moderate increases in density and mixed use. Gross population density and net residential density greater than 20 per hectare.
B	Moderate density cities characterized by relatively large portions of non-contiguous development, but containing some mixed use nodes. Gross population density and net residential density of 5 to 20 per hectare.
C	Low density cities with a large proportion of non-contiguous development and exurban land; usually with no significant mixed use area. Gross population density and net residential density less than 5 per hectare.

Table 3.2 Initial Conditions and Performance Targets

	Initial % of Total Population			**BAU** % of New Growth			**CEP** % of New Growth		
	Node	**Compact**	**Sprawl**	**Node**	**Compact**	**Sprawl**	**Node**	**Compact**	**Sprawl**
A	10%	30%	60%	20%	40%	40%	50%	50%	0%
B	5%	20%	75%	5%	20%	75%	30%	70%	0%
C	0%	10%	90%	0%	10%	90%	30%	70%	0%

At the 1991 census, 28% of BC's population lived in Type A communities, 19% in Type B and 54% in Type C. At 1991 growth rates, the split in 2010 changes only slightly to 22% in Type A, 25% in Type B and 53% in Type C.

3.2.2 Results

The model suggests that the results of a shift toward more compact and complete communities (i.e., increased density and mixed use) will be carbon dioxide emission reductions of 15% (7.8 million tonnes annually), and cost savings of 18% ($5.2 billion annually). *Savings* per tonne of abatement are $657 per tonne. These cost savings result from savings on equipment purchase, operating costs (fixed and variable), fuel consumption, and road infrastructure and related land acquisition costs. They do not include savings associated with other municipal infrastructure such as water supply, sewerage and drainage, police and fire services, etc..

Testing for Sensitivity to Underlying Assumptions

To determine the sensitivity of the results to changes in the underlying assumptions, a series of sensitivity analyses were performed (Table 3.3). "Worst Case" involves:

Space Heat	• Decreasing the achievable market share of alternative technologies for Compact and Node by 10%; • Halving the multipliers used to estimate the relationship between cost and density (including conventional gas and electricity grid).
Electricity	• As above but for electricity.
Transportation	• Decreasing modal share of each alternative transportation mode in Node and Compact by 10%; • Increasing modal share of alternative modes in Sprawl by 10%; • Halving the multipliers used to estimate the relationship between cost and density.

Table 3.3 Worst Case Projections

		Base Case	% Change in Results from Changes to:		
			Space Heat	Electricity	Transportation
Cost Savings	billion $ / year	$ 5.2	- 5.3 %	- 4.0 %	- 9.2 %
CO_2 Savings	million tonnes/year	7.9	- 1.1 %	< 1.0 %	- 4.2 %
Abatement Cost	$ / tonne	$ (657)*	+ 4.3 %	+ 3.9 %	+ 5.3 %

* Denotes negative costs (i.e., savings). % change is positive because the abatement cost increases (meaning that the savings decrease by the percentage shown).

The results indicate that the assumptions about transportation modal shares and costs are more critical to the estimate of reduction potential than those about space heating and electricity. This is largely due to the relatively clean fuel supply used in BC for building energy (i.e., the predominance of hydro-electric power and natural gas). They are also more critical to the estimate of cost savings, although the difference is less marked.

Testing the Impact of Uncertainty

The assumptions about district heating market share and cost variability are characterized by a high level of uncertainty due to the influence of other factors beyond density on technology costs (e.g., corridor accessibility, existing heating and ventilating systems, etc.). To test the impact of changes in the assumptions about this technology specifically, a second sensitivity analysis was performed. The results suggest that relatively large changes in the assumptions about cost (halving the multipliers) and market share (decreased by 10% in compact and node) result in very small changes (less than 1%) to overall cost savings, emission reduction potential and abatement cost.

Testing the Relative Contribution of Alternative Development Classes

Further analysis was performed to determine the relative contribution of shifting from sprawl to compact versus from compact to node. The results suggest that cost savings and emission reduction potential are both roughly 5% greater when populations are transformed from sprawl to compact. Although small, this difference is consistent with Holtzclaw's (1993) findings that the greatest benefits of density increases will be realized by bringing low density areas up to more moderate densities through selective redevelopment.

3.2.3 Discussion

Model Performance

Much of the analysis in this study is performed using assumptions based more on professional judgement than on hard data (e.g., the relationship between costs and density, achievable market share, etc.). Some of the judgements are open to criticism on the basis that costs are site-specific and generalizations are difficult. However the sensitivity analyses suggest that the results are relatively robust to changes in the most uncertain parameters. Transportation modal share and modal costs are the factors having the greatest impact on the costs and emissions savings associated with density increases. Fortunately, the uncertainties associated with these factors are lower than those for the building technologies. Performance targets for modal share are common in the literature, and those used here can be considered quite conservative[25]. Less well documented is the relationship between transportation costs and density, an area meriting further study.

The assumptions about the variation of energy consumption with density also has a significant effect on the results. These multipliers are relatively well-documented or based on realistic calculations (refer to Box 3.5).

Density in Context

It is worth repeating that strategies that increase overall urban density are not sufficient to achieve the benefits identified here. For example, it is possible to achieve density targets for different classes of development by reducing lot sizes in neighborhoods that remain essentially single-use single family dwelling neighborhoods. Also, in a majority of BC communities, there is so much exurban land within urban boundaries that any new development, even at the edges of the urban boundary, will increase overall urban density. However, unless neighborhoods are designed with a mix of uses, located contiguous to existing development, and served by transit and pedestrian

[25] The GVRD's Long Range Transportation Plan for Greater Vancouver forecasts that by 2021, transit will achieve 48% of person trips in the morning rush hour to the downtown peninsula, 29% to the regional town centres, and 18% within the region overall. Current transit share of all trips in Vancouver is 35%, in Surrey is 3.9% and in Coquitlam is 5.3% (BC Transit, 1995). This study uses 30% for nodal areas, 15% for compact and 5% for sprawl.

facilities, the expected benefits will not be achieved. Density increases will make it possible to provide mixed use and alternative transportation facilities, but density increases alone will not provide the cost and emission reductions identified here.

Archetypes, Indicators and Performance Targets

The development of suitable indicators and performance targets was limited in this exercise by the availability of data on density and mixed use characteristics at the neighborhood scale. For most communities this data does not exist in a useful format; where it does exist there is little consistency among communities with respect to the definition of appropriate indicators. This problem is not specific to BC, but is found throughout North America (Holtzclaw, 1995). It was not possible to confirm assumptions made about initial density conditions even in communities with Geographic Information Systems (GIS) due to lack of neighborhood scale data. Similarly, useful indicators of mixed use, such as local job density (e.g., number of service jobs per hectare) or local jobs-to-labour force ratio were not available.

Gross population density (people per hectare) and net residential density (dwelling units per residential hectare) were used as guides in establishing the three community archetypes (see Appendix B2). An inventory of travel characteristics (e.g., VKT per capita) would also be useful in classifying communities into archetypes. However, data availability is a barrier in BC outside of the Lower Mainland.

Further study on indicators, initial density and mixed use conditions at the neighborhood scale, and realistic performance targets would help to refine the development class and community archetype definitions and to firm up the data input to the modelling framework developed here. Appendix B5 contains a discussion of some potentially useful indicators for density, mixed use, transit access and pedestrian access. Assuming that these data were available, it would be possible to establish realistic development guidelines and performance targets. The following framework is proposed for development classes.

Objective	Indicator*	Development Class	
		Node	Compact
Density	Net Residential Density	> 40 dwellings/ha	15-40 dwellings/ha
Mixed Use	Neighborhood Service Index	*Establish Performance Targets*	
Transit Access	Transit Accessibility Index	*Establish Performance Targets*	
Pedestrian Access	Pedestrian Accessibility Index	*Establish Performance Targets*	

* See Appendix B5 for indicator definitions.

Different communities may set different performance targets with respect to the percentage of new development that may occur in different development classes. Additional development classes may be added.

A similar framework for community archetypes using broader indicators such as net residential density, and per capita VKT can be developed.

Greenhouse Gas Abatement Cost

The abatement cost of land use planning as a tool for CO_2 emission reduction is not a cost at all. In fact, society saves roughly $650 per tonne of CO_2 abatement. These savings are the result of decreased energy consumption, a shift to more cost-effective supply technologies, a shift to more cost-effective transportation modes, and lower costs associated with road infrastructure. The total reduction potential of 7.9 million tonnes or 15% versus a business-as-usual scenario is a conservative figure, accounting only for altering the patterns of new growth. Assuming that half of the new growth occurring in compact communities also transforms an equal number of people from existing sprawled suburbs into compact neighborhoods (i.e., through redevelopment or infill), and that half of the new growth occurring in nodes transforms an equal number of people in existing compact neighborhoods into nodes, the total reduction potential increases to 10.7 million tonnes or a 21% saving versus business-as-usual, at a similar level of savings per tonne ($654/tonne).

SECTION 4 IMPLEMENTING CEP

The previous sections have helped to define CEP and to evaluate the potential for communities, utilities and society as a whole to realize benefits from it. The next question is how to implement it. What is the legal basis for municipal involvement in energy planning? How can the provincial government and energy utilities support implementation? What are the technical, social and economic issues that community and utility planners face? These issues are addressed in Section 4.1. To translate this conceptual discussion of implementation issues into a concrete application, Section 4.2 presents an implementation case study. The case study outlines the technical basis for the application of micro-cogeneration at a new development site, estimates the economic and environmental performance of the system, and identifies the opportunities and challenges faced by the proponents of such a system.

4.1 Implementation Issues

4.1.1 Legal Issues[26]

The primary legislation relevant to municipal authority in BC is the Municipal Act[27], which does not expressly mandate municipal government to take action with respect to energy objectives[28]. This creates a difficulty for CEP, but it is not a barrier. Local governments have considerable powers to pass bylaws and to regulate business and development, provided they are: (a) acting in the interest of the municipality as a whole, and (b) exercising their powers in a non-discriminatory manner. The following sections identify opportunities for municipal action under these powers.

The Growth Strategies Act (GSA) is a recent amendment to the Municipal Act which provides a legal basis for addressing many of the objectives of community energy planning at the regional level. Under the GSA, growth management plans are developed jointly by municipalities and the

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[26] This analysis is specific to the province of BC. Other provinces may have significantly different statutory arrangements.

[27] The City of Vancouver is governed by the Vancouver Charter which may in some cases present them with different opportunities and constraints than those discussed here.

[28] This is likely to change as the Ministry of Municipal Affairs is considering recommendations to that effect made by the BC Energy Council in 1994.

regional district, and are binding on the municipalities who sign off on the plan. The GSA states that "the purpose of a regional growth strategy is to promote human settlement that is socially, economically and environmentally healthy, and that makes efficient use of public facilities and services, land and other resources." Section 942.11(2) explicitly states that a regional growth strategy should work toward "planning for energy supply and promoting efficient use, conservation and alternative forms of energy". Since no regional district has yet undergone the review processes established under the GSA, there is no precedent set as to the interpretation of what constitutes such energy planning. Nonetheless, the authority for municipal involvement through joint municipal-regional growth management planning processes is clearly provided.

Some communities will find that is preferable to address community energy planning within the context of the region and the regional growth strategy. However, there will remain many instances where communities wish to pursue energy planning initiatives on their own, either where regional growth management plans are not implemented, or where communities wish to implement initiatives beyond those prescribed in a growth management plan.

As the following sections will show, the extent to which local government can specifically address energy issues and control development with respect to energy and other objectives could be improved with more enabling legislation - either new legislation or amendments to existing Acts. However, this fact should not be the cause of inaction. Multiple sources of local authority are identified which justify action under the municipality's broad mandate to manage business and development in the public interest. Provided official planning documents are prepared with research and foresight, it is apparent that a local government committed to the concept of community energy planning and sustainable community design can go a long way toward achieving its objectives with the authority it has under existing legislation. What is needed is to overcome the historical hesitancy that local councils have tended to exhibit to exercise their powers, and to do so with sufficient supporting documentation that the courts will be unable to find that they have acted on an inadequate factual basis.

Land Use Planning

In order to meet the objectives of the land use planning package and, to a large extent, the site design package, local government must have explicit legal authority to regulate development, including development on privately owned lands. Part 29 of the Municipal Act addresses the management of development. It includes community plans, designation of special areas for development and the conditions which may be attached to development permits. The Land Title Act is the other significant piece of legislation affecting the control of development.

Zoning Official community plans have only a limited legal basis, but they generally result in the passing of zoning bylaws. The power to zone according to community development objectives is the strongest, most unambiguous tool for controlling development that the municipality has. Insofar as planning departments can proactively design official community plans and creatively extend and detail zoning requirements, they will increase their ability to meet CEP objectives.

Development Agreements Written development agreements are rare, but they are becoming more common. While there is no clear statutory authority for such agreements, if a developer enters into one voluntarily, case law suggests it is enforceable (Rogers, 1994b). Where developers require rezoning to implement their plans, it is standard practice for municipalities to enter into negotiations with the developer in the interest of ensuring that the development meets public interest objectives. From these negotiations, written development agreements may emerge. While the statutory authority for such negotiations and agreements is unclear, local government is under no legal obligation to exercise its authority to rezone. Thus, local government is in a strong negotiating position, and the developer has nothing to gain from challenging the legality of the requested changes or concessions (Lidstone, 1990).

Where rezoning is not required, the legal authority of the municipal government to demand consideration of alternative energy systems or development standards is limited. There are conflicting opinions on the outcome of a court decision on such demands. While municipal bylaws generally receive a "benevolent" interpretation in the courts (MacDonald, 1991) and will be supported if possible, there is significant case law suggesting that the courts are very reluctant to allow undue intervention in business and development activities that are not clearly unlawful

(Rogers, 1994). A recent case in which the City of Toronto was found to have exceeded the bounds of its legal jurisdiction has left municipal governments on uncertain legal ground.

Where a local government has carefully documented its case to demonstrate that the restrictions or standards under consideration are necessary in the public interest, its chances of success are improved. For the implementation of CEP strategies, such documentation may involve demonstrating that the proposed technologies:

- contribute toward municipal and regional air quality or transportation objectives;
- contribute toward municipal and regional cost-of-service objectives;
- do not impose undue financial burden on the developer;
- do not prevent the development of the land in question;
- contribute toward the goal of affordable housing by lowering the cost of living through economical heating services.

<u>Development Permits</u> Development permits are a potentially important source of regulatory control over development, however they are currently limited in at least two important ways. First, they apply only to specifically designated areas in the official community plan, and second, they may not be used to insist upon requirements not otherwise authorized in the Municipal Act. Requirements must relate to the general character of the development, not the particulars, suggesting that local government might have a difficult time requiring that developers provide continuous cycling/walking pathways, bus shelters, clustered homes and solar orientation rather than just aesthetic improvements. As a general principle, a court would not likely allow the imposition of involuntary conditions on developers. Nonetheless, municipalities may attempt to seek voluntary concessions from developers to protect community objectives.

<u>Incentives</u> Beyond legally enforceable requirements, municipal government can also offer developers a number of carrots to get the concessions it wants. For example, a fast-track approval process could be offered for developers who include energy efficient design - both passive (building design and transit- or pedestrian-friendly design) and active (alternative energy supply). For developers, approval time is important. Delays resulting from the need for environmental review by a municipal environment committee, community stakeholder group, or some other entity, could be

expensive. Further, commitment by the city to support a building rating system that allows developers to market a building on the basis of its environmental performance could result in higher sale prices.

Building Permits Section 981 of the Municipal Act prevents local government from withholding a building permit unless it is in direct conflict with an *existing* plan or bylaw. What this means is that unless local government has prior knowledge that a development of a certain type is about to be proposed, they have no opportunity to prevent or modify that development through a development permit or new bylaw. This is a barrier to the ability of local government to control and direct development in the long-term public interest.

Affordable Housing Local government has the explicit authority to require developers to conform to minimum requirements for affordable housing (Section 945(2.1), Municipal Act). Since housing types which are inherently more affordable are those which are also inherently more energy efficient (shared walls, vertical stacking), energy objectives as well as urban containment objectives can be indirectly met through this mechanism.

Subdivision Approval Section 85(3) of the Land Title Act suggests the approving officer might have broad powers to refuse development that is inconsistent with emerging trends in growth management. However the courts have tended to interpret the powers of the approving officer very narrowly, and have overturned development refusals on the basis that the officer was "paternalistic" (Cotterall v. City of Vancouver, 1985), or acted on an "inadequate factual basis" (Clay v. Spaxman, 1985). Such precedents suggest that a shift will need to occur with respect to the court's perception of the relative importance of private versus public rights; i.e. protecting the individual's right to develop privately owned property, versus protecting society's right to clean air and the environmental amenities and essential services provided by the preservation of agricultural lands, wetlands, forests and recreational green space. Amendments to the Act to more clearly define and expand upon what the "protection of the natural environment" might entail are necessary. Such a definition should include not only streams, other habitat and viewscapes which are commonly thought of as the natural environment, but also, at minimum, air quality and general trends of land consumption.

Development Cost Charges Development cost charges (DCCs) are charges levied against developers at the time of development. They are authorized under Section 983 of the Municipal Act, and exist for the purpose of recovering capital costs associated with sewage, water, drainage and highway facilities, as well as the provision of parkland. They may vary among zones or areas within zones, among uses, among different types of development as those types impact capital costs, and among developments that vary in sizes and numbers of units. In fixing DCCs, the Act states that the local government must take into consideration future land use patterns and development, the phasing of works and services and the provision of parkland in an official community plan along with ensuring that the charges are not so excessive as to discourage development or affordable housing.

Clearly the Municipal Act thus stated allows DCCs to be used to encourage high density development, vertical expansion, multi-family residential units, and increased mixed use structures in targeted intensification areas, on the basis that such developments vary with respect to capital costs associated with water, sewage, road and drainage infrastructure. On this basis, DCCs have the potential to be a powerful economic tool for encouraging development that is compatible with the long-term objectives of a community. In light of section 984(2), which implies that DCCs not be so high as to deter development, it is important that changes to DCCs be essentially revenue-neutral and used as both carrot and stick; that is, set high for development that is not preferred, but low and affordable for development that meets preferred standards.

Transportation Management

Licensing Businesses Establishing measures that increase average vehicle occupancy rates and encourage fleet fuel switching may be addressed in part through local government's powers to regulate business under Section 526(1) of the Municipal Act. MacDonald (1991) suggests that a municipal council may subject a license to "such reasonable provisions and restrictions as they see fit to impose on exercising the right to carry on that trade". The courts in general have tended to strictly interpret the municipal power to interfere with the common law right to carry on a lawful business, however, they also respect the right of the municipality to regulate for the good of the community. While a municipality may be unsuccessful in passing bylaws made for the purposes of achieving energy objectives, there are other reasons for mandating trip reduction programs that could fall under the municipality's authority for health and safety. Air quality concerns or traffic congestion and safety could be valid considerations under the municipality's mandate to "regulate the carrying on of business...for the purpose of protecting the public" (Section 526(1)). Precedents have been set by municipalities in BC, as elsewhere in Canada, who have exercised their power to regulate in respect of air quality objectives in the public interest (e.g., smoking bylaws). To the extent that it can be shown that the regulations do not undermine the viability of the business and are not unduly discriminatory, they are more likely to be successful. Further, the Motor Vehicle Act offers support of municipal jurisdiction in this area (Section 211.1(1)(z) which refers to licensing of groups of vehicles as fleets, and Section 120(3) which deals with municipal authority).

<u>Managing Municipal Roadways</u> Section 120(3) of the Motor Vehicle Act suggests that municipal government has the authority to establish high-occupancy vehicle lanes and/or tolls on the basis of levels of traffic. However, since the most likely candidates for tolls will be provincial arterials, the involvement of the province may be necessary.

<u>Dedicated Legislation</u> In spite of the existence of several apparent sources of municipal authority, the regulation of vehicles is a controversial issue with far-reaching implications and a high public profile. For these reasons, it is recommended that dedicated provincial legislation be enacted to address the broad issue of vehicle regulation. Besides performance standards for efficiency and emissions, this could include regulations governing employee trip reduction programs and fleet fuel switching, the implementation of which might be delegated to local government. Such legislation could be implemented by the Ministry of Energy, Mines and Petroleum Resources (MEMPR) or the Ministry of Environment, Lands and Parks (MELP).

Site and Building Design

Some of the measures in this package, namely incorporating the use of microclimate in approval processes and orienting lots and buildings for solar gain and clustering effects, are largely dealt with through the same processes as outlined under *Land Use Planning*. Clearly, municipalities have the authority to invest in efficiency programs in municipal buildings. The only real barrier is one of financing which is considered below. Measures designed to increase the penetration rate of energy efficient technologies can be considered from two perspectives: the authority to implement assistance programs, and the authority to actually increase the efficiency requirements of buildings and appliances within municipal boundaries.

Assistance Programs The implementation and funding of any substantial initiative to provide financial or technical programs to support community-wide investments in energy efficiency or alternative energy resources would need to be clearly outlined under policy initiatives in an official community plan. Since Section 945(5) of the Municipal Act forbids the formation of explicit policy with respect to matters which are not within the jurisdiction of the local government, it would be difficult to formulate plans, targets and budgets for energy objectives. Amendments to the Act are thus seen as a key reform for the involvement of municipal government in energy management to be effective.

Building Standards The efficiency requirements of buildings are set by the building code, which is administered by the Building Standards Branch of the Ministry of Municipal Affairs. Enforcement of the code lies with municipal building inspection departments. McCaughan-Morrison (1989) suggests that a municipal bylaw that attempted to directly address alternative standards would be considered invalid if it was inconsistent with the provincial building code and its regulations. Whether a code which is more strict than the provincial standard could be considered inconsistent is a matter of some controversy (Barry, 1994). However, a municipality could, under powers for health and safety, pass bylaws requiring mandatory building performance standards generally (such as provision of cycling facilities and showers), and mandatory building certification. This would meet the broad objective of informing building owners and occupants of the characteristics of the buildings they occupy.

Retrofit Standards The energy performance of buildings constructed twenty to forty years ago still impacts energy consumption. There is currently no provincial code specifically addressing standards for retrofits of existing homes. Any time renovations are proposed on older buildings, owners are required to bring the building up to current standards of energy efficiency as outlined in the provincial building code. However, these standards are often incompatible with older building stocks (e.g., with respect to fundamental structural components like wall thicknesses etc.) making retrofits uneconomical. Owners often opt not to renovate at all. A retrofit code which makes allowances for the design standards of older buildings and defines cost-effective energy efficiency retrofits is necessary to facilitate the widespread adoption of efficient standards. A "ratchet" approach to implementing retrofit standards might also be considered, which involves mandating incremental improvements to older buildings at the time of each resale.

Alternative Supply

Zoning Zoning on the basis of energy objectives would require the addition of energy to Part 29 of the Municipal Act. Even without explicit authority with respect to energy however, it is possible to set zoning standards on the basis of "special areas for development" without specifying energy as the primary objective. Density, mixed use, rate of growth and site standards can all be included so as to support energy alongside other community objectives. At this point, the opportunities and barriers discussed under *Land Use Planning* are relevant.

Development Cost Charges One potentially powerful market-based instrument to encourage alternative energy forms is development cost charges (DCCs). The purpose for which DCCs exist (namely, to help recover the capital costs of infrastructure) and the requirements for setting the charge (namely, that future land use patterns and phasing of works be considered), are compatible with the use of DCCs to encourage alternative types of energy equipment in buildings. For example, using DCCs to encourage heat pumps and district heating connections and discourage electric baseboard heating is justified on the basis of avoiding future costs of conventional electricity and gas service. Some form of full-cost accounting may also be used to account for differences in air emissions associated with alternative technologies. However, because the capital cost of energy infrastructure is not normally covered by the municipalities, energy-related DCCs are better implemented through the energy utilities[29]. Utilities currently charge hook-up fees to developers, however there is generally no sliding scale to create incentives for selecting one type of energy system over another. While strictly speaking, these fees are not DCCs, sliding hook-up fees implemented by the utility in partnership with the municipality can help municipalities achieve energy-related objectives. Where district energy zones or solar zones are to be established, cooperation between utilities and municipalities allows DCCs to vary among zones as well as among technology choices. Financial incentives would then be in place to encourage on-site

[29] Where a municipal utility exists, the rationale for legal authority with respect to energy services is, in theory, comparable to that for roads or sewerage.

resources such as heat pumps, solar photovoltaics and micro-cogeneration, as well as district heating.

Municipal Utilities Under Section 632 of the Municipal Act, a municipal council may provide for the establishment and use of energy supply and distribution systems in the municipality. A municipal utility may be formed, which would own and manage the energy supply services, or the municipality may contract with any private producer or distributor of energy services. Thus there is no legal barrier which prevents the municipality from implementing a district heating system or a combined heat and power plant to provide energy services at the community level. On a practical level however, it is the municipality's limited access to capital and/or perceptions of risk that will inhibit the spread of municipal involvement in the capital intensive energy supply industry.

Financing While there are arguments to be made for revising the rules and requirements of borrowing and financing at the municipal level, there remain sound reasons for limiting the extent to which municipal government can become indebted. The solution is less likely to be found in liberalizing borrowing terms than it is in developing partnerships with those provincial agencies and utilities who have the means of raising capital. This requires a fundamental change to the way decisions are made and implemented at all levels of government.

4.1.2 Social, Economic and Technical Issues

The following describe some of the social, economic and technical issues that became apparent during the execution of the case studies in Section 3.1.

Resistance to Change

Resistance to change is one of the key challenges facing planners in the 1990s in the Northern regions of the province (Urban Development Institute, 1993). Many of the ideas proposed in the land use and transportation management packages are likely to be met with resistance from a population which has located in the North largely to avoid urbanization.

Trade-offs Among Competing Objectives

CEP, like all community planning processes, involves trade-offs. Local air quality is one area where CEP may lead to conflict. Province wide, carbon dioxide emissions will drop significantly through a CEP initiative. Where wood waste plants displace beehive burners, no net change in emissions of nitrous oxides and particulate matter will occur, however where wood waste fuel is trucked in from elsewhere, local emissions will rise. Multi-stakeholder negotiations with municipal authorities and community representatives will be required in order to make trade-offs with respect to local environmental quality.

Climate

Long severe winters in northern areas will limit the extent to which some of the measures can be implemented. Cycling and walking are limited practically to only four months of the year in many northern communities. Waiting for transit at thirty five degrees below zero will seem a poor transportation option. CEP approaches must be adapted to suit local conditions. For example, the Prince George case study suggests greater emphasis on car pooling and HOV facilities than on transit and cycling.

Risk Perception

Unfamiliar technologies with unfamiliar environmental consequences and high capital costs are seen by municipalities and the public as high risk ventures. In spite of the overall environmental improvements that may be achieved by having a single efficient point source over multiple inefficient ones, public opposition and political reluctance are likely to be difficult to overcome, especially in smaller communities with limited resources and budgets.

Developer Resistance and Inter-Community Competition

Developers generally prefer to develop greenfield areas. It's easier, cheaper (in the short term) and the market is proven. Communities in relatively close proximity to one another are in constant competition for development, and the perception of local planners is that if too many barriers are erected in one community, developers will move on to a neighboring one. This competition places communities in a weak bargaining position.

Peak, Load and Capital Intensive Systems

While reductions in peak load help to improve the economics of capital intensive systems, reductions in energy consumption do not. Therefore, there will be a practical trade-off between maximizing energy efficiency and recovering the costs associated with capital investment. However, a Swedish study (Gustavsson, 1994) suggests that district heating is not incompatible with energy efficiency objectives. Managing growth in consideration of district heating zones helps to offset the effects of reduced energy demand. In addition, demand can be managed to improve peak and base load characteristics and thus overall capacity utilization.

Allocating Limited Resources

In any community type, which strategies to focus on depends to a large extent on the specific objectives of planners. If the objective is emissions reduction, the transportation management and land use planning policy packages should be targeted. This is because of the significantly higher emissions rate from conventional auto fuels versus the emissions from hydro-electric and natural gas sources. However if improvements in local economic development or employment are desired, more leverage may be available through improvements in site and building design and increases in local supply. Consistent with the integrated nature of CEP, no one sector should be targeted to the exclusion of another, but the realities of limited financial and technical resources suggest that it is valid to choose strategic sectors to target most intensively according to local planning and development priorities.

Utilization of Wood Waste

The case studies suggest large benefits arising from the utilization of wood waste in district heating/cogeneration systems in BC. However, any initiative to increase the utilization of wood waste province-wide must incorporate an analysis of current trends in the forest products industry. Relative to existing mill capacity, the industry currently faces a wood shortage in BC. This shortage has encouraged a trend toward increased recovery in sawmilling and pulpmill operations. Further, projections of sustainable yield suggest that declining annual allowable cuts are inevitable in most regions of the province over the coming decades. A decision to increase the level of long-term investment in an energy resource that is declining in availability should be carefully considered. Similarly, investing in an initiative that is likely to discourage the current trend toward greater wood recovery may be a short-sighted and piecemeal approach. What appears to be a move toward sustainability in the energy sector taken alone, may in fact be a move in the opposite direction under a multi-sectoral analysis. The issue will be one of scale, implying that provincial-municipal cooperation will be needed in prioritizing which communities have the best opportunity and will receive the most benefit by utilizing wood waste.

Option Preservation

While it is acknowledged that urban land use planning is not a high local priority in smaller communities today, moving toward a more compact community form remains an important long-term strategy, both for designing a more livable community for the future, and for option preservation objectives. For example a sustainable sawmilling operation might one day provide a cost-effective fuel source for district heating, but a sprawled urban form would make the costs prohibitive; solar photovoltaics will eventually become economical for home use, but only if lot orientation, developed over decades of planning decisions, is favorable.

Technical Guides and Standards

Even planners and developers who want to implement CEP strategies feel handcuffed by a lack of useful guides and tools for doing so. Practical manuals of development standards, containing information ranging from optimal roof pitches for solar gain to maximum setback of stores from transit facilities, are necessary to assist them in planning sustainability into new developments.

Life-Cycle Costing

The acceptance of life-cycle costing and the adoption of a social discount rate in making energy investment decisions is critical to a favorable economic analysis. While utilities are now mandated to accept this method of economic evaluation, many decisions made by other government agencies and businesses remain guided by "least-first-cost" solutions and real discount rates of twelve to twenty per cent or more. This raises the question of who pays for community energy planning. Notwithstanding the importance of evaluating options based on life-cycle costs, the price tag of the small hydro system proposed in the Anahim Lake case study is in the order of $6.0 million, versus just over $1.0 million for a new diesel generating plant. Overcoming the barriers of availability of capital and favorable financing terms will be a major challenge to efforts to reshape the provision of energy services, especially in non-integrated communities.

4.2 Implementation Case Study

The purpose of this case study is to translate the hypothetical analyses of the previous sections into a concrete application with recommendations for local government and energy utilities to implement some of the key principles of CEP.

4.2.1 Background and Rationale

The Westminster Quay Project is a proposal for a development on the eastern downtown waterfront area of the City of New Westminster, BC. Proposed by Larco Investments Inc., it will consist of five residential towers, a major museum and the Westminster Quay Public Market. According to the 1994 Queensborough Official Community Plan, the City of New Westminster has a commitment to new and innovative approaches to the provision of services and utilities, as well as a commitment to ensure that new development adheres to energy efficient principles. The location, scale and estimated energy requirements of the Larco development suggest that it is a promising candidate for an alternative energy system.

Specifically, the objectives of the case study are:

- to demonstrate the potential benefits of an alternative energy system for developers, local government and communities;
- to identify the barriers and opportunities from the perspective of regulatory agencies, building owners, and local government, for this project specifically and for others like it; and
- to investigate various options for implementation.

There are a wide variety of new energy technologies on the market today that are cost-effective in appropriate applications. Water and ground source heat pumps have become mature technologies with proven operating and economic performance records in a variety of applications, especially in coastal climates. Distributed generation technologies are also commercially available and competitive in suitable applications. Without a detailed analysis of each of these and other technologies, it is not possible to say which represents the best option for the specific conditions of the Westminster Quay Project. However, the remainder of this study will develop the option of micro-cogeneration to serve as one example of what might be technically and economically feasible on this site.

4.2.2 Distributed Generation: Technical and Economic Analysis

Technology Description

The micro-cogeneration units under consideration in this report are natural gas engines with full recovery of the heat produced by the engine. The units are generally sized to meet base load electricity demand, and are most economical when the resultant thermal capacity can be fully utilized to meet the building's heating or cooling load. The equipment can be installed either in the basement of a building or in a separate utility building. Enclosed in its self-contained unit, the noise level at 10 meters is estimated at 65 decibels - roughly that of street level traffic. The equipment footprint for 500 kW is roughly four meters square (Himmler, 1995).

The micro-cogeneration unit is normally supplemented by a gas-fired boiler unit that meets peak heating demand. Residual heat from the cogeneration unit is fed into a header and distribution system which is connected to the conventional boiler system, and all other aspects of the building construction and energy systems remain as they would for a conventional central hot water heating installation.

Design Basis for the Westminster Quay Development

The Westminster Quay Project as proposed by Larco Investments includes five residential towers and thirty townhouses for a total of 1000 housing units, as well as the public market and the Fraser River Discovery Centre (a museum). Floor space and housing units are distributed as follows:

Site Area	**6.84 acres**
Floor Space	
Residential	947,000 sq. ft
Commercial (including museum)	121,000 sq. ft
Total	**1,068,000 sq. ft**
Housing	
Towers (5)	970
Townhouses	30
Total	**1000 units**

Equipment Specifications

Based on average consumption figures for buildings of similar configuration and use, the peak load for electricity (including electric space heating and hot water) is estimated at 3 MW, with a base demand of 1.0-1.5 MW. The cogeneration unit is therefore sized to meet a base electrical demand for the whole development of 1 MW. The thermal output of this equipment is roughly 1.6 MW. To maximize availability of the equipment, the total required capacity would be installed as two units of roughly 500 kW each.

Implementation Options: Who Pays? Who Profits?

There are several options for who bears the risks and receives the benefits of the project.

Option 1. Contingent on a favorable economic analysis, a private energy service company may offer the building owner full financing up front, with a guarantee to the building owner that s/he will realize a fixed percentage of savings on the expected annual energy bill. The remainder of the savings realized each year go to the energy service company to pay off capital costs and provide a return on investment. This arrangement may continue indefinitely for guaranteed "hands-off" savings for the building owner. The system may be owned either by the energy service company outright, or by the building owner with financing from the energy service company.

This option is the most generic option, and is especially relevant for commercial developments, where the building owner expects to pay the ongoing costs of energy services. For developments where the developer intends to pass on the ongoing costs of energy services to tenants (as is the case in most new residential developments), one option is for tenants to form a consumer cooperative for the provision of heating services. The energy service company will then work directly with the cooperative, and as before, the system may be owned either by the cooperative or the energy service company.

Option 2. The building owner may opt to buy the cogeneration facility outright. In this case, s/he realizes all of the savings and assumes all of the risks. The payback is in the form of savings, or "avoided cost" of heating services. Alternatively, if the building owner intends to pass on operating costs to tenants, s/he may invest in the micro-cogeneration facility as a business opportunity, where the payback is achieved through the billing of customers rather than the avoided costs of heating services.

Option 3. New Westminster is one of the few municipalities in BC that has a municipal energy utility. Thus, the opportunity exists for the municipal utility to effectively act as the energy service company. The equipment supplier would size and design the equipment, but the municipal utility would own and operate the system, set up financing and/or servicing terms with the building owner or consumer cooperative as in Option 1 above, and earn a substantial return on investment[30]. Alternatively, the municipal utility might simply acquire the cogeneration facility as a source of power in addition to its bulk purchases from BC Hydro. Then it would sell electricity to individual consumers at prevailing retail rates. In either case, in order to be financially attractive to the utility, the levelized annual cost of electricity provided by the cogeneration unit must be lower than the bulk rate - both current and expected future rates - at which the utility purchases electricity from BC Hydro.

Each of the options represents a potential opportunity to meet the objectives of all parties:

- the site developer (e.g., Larco Investments), with respect to operating costs and marketing opportunities (e.g., affordability, comfort, environmental performance);
- the municipality, with respect to costs, revenues and the City's energy and service objectives;
- the consumer, with respect to affordability of heating services;
- the regulated energy utilities, with respect to the avoided costs of increased transmission access into the Lower Mainland (BC Hydro), and increased business opportunities (BC Gas);

[30] The opportunity to earn a substantial rate of return assumes that the energy system owner is exempt from regulation under the BC Utilities Act, an assumption that is discussed in Section 4.2.3.

- the general public, with respect to economic objectives, environmental concerns, and avoidance of potential land use conflicts associated with increased transmission access.

Each option also faces a number of potential barriers. These are discussed in detail in Section 4.2.3.

Economic Analysis

Economic analysis of the proposed energy system requires that three things be clear:

1. What is the baseline against which we are comparing?
2. What is the alternative we are evaluating?
3. From whose perspective is the analysis done?

The answer to the first question will vary from site to site. In the case of the Larco development, it appears that the energy system that will be installed in the absence of any review of the options will include:

- electrical resistance heating in each residential unit
- electric hot water tanks in each unit
- individual electric metering in each unit (i.e., each unit owner will pay the cost of heating services)

This system then constitutes the baseline or "business-as-usual" system.

The second question requires clarification of which of the options under consideration is to be evaluated. This analysis will be limited to consideration of Option 2, where the building owner or developer is the energy system proponent and invests in the system as a business opportunity, recovering capital costs through the sale of energy services to unit owners. This option is chosen because it most closely reflects conditions at the Larco development and it allows the inclusion of all relevant costs in the most straightforward manner. From a technical perspective, the alternative under consideration includes:

- central hot water space heating
- central hot water heating
- individual hot water and electric metering in each unit.

The answer to the third question is that several analyses must be done. First, a "societal test" is required to ensure that there are net benefits to be achieved with the adoption of the alternative energy system. Then an analysis must be done from the perspective of each of the major stakeholders to determine how those benefits are distributed. The major stakeholders include the building owner, the municipal utility, the consumer and the energy system proponent. Depending on the option to be evaluated, the importance of an analysis from each perspective will vary. In the analyses which follow, benefits are calculated from two perspectives: 1. social; and 2. the building owner, where the building owner is also the energy system proponent in the option under consideration.

Perspective: Social

Assuming that each energy system provides equal benefits in terms of energy services, the *social* economic analysis is concerned only with minimizing the total cost of the provision of services. That is, the distribution of those benefits, while important, is not addressed. The objective is to determine whether one option yields cost savings over another; the details of how to distribute those savings can be dealt with in a more detailed analysis.

Box 4.1 shows the data used and the method of calculation for the societal test. The result of the calculation indicates that the levelized (or annualized) cost of energy services provided by the cogeneration system is $0.047/kWh (electricity and heat equivalent), while that of energy services provided by the utility grid system is $0.063/kWh[31] . Thus an opportunity exists to realize net savings for society by moving to an alternative energy system. This calculation is based on purely financial factors, with no consideration of environmental or social externalities.

[31] The use of this rate includes overhead costs, which may slightly overstate the benefits of the district heating system over the utility grid.

Box 4.1 The Societal Test

The economic analysis of alternatives from the broad social perspective is performed using levelized capital costs according to the following:

$$LCC = \frac{CC(CRF) + OC}{kWh_e + kWh_{th}} \; ; \qquad \text{where } CRF = i/(1-(1+i)^{-n})$$

and

LCC	=	Levelized Capital Cost
CC	=	Capital Cost
CRF	=	Capital Recovery Factor
n	=	Life of the project
i	=	Discount rate
OC	=	Annual Operating and Maintenance Costs
kWh_e	=	Annual energy consumption for electric service
kWh_{th}	=	Annual energy consumption for thermal service

DATA INPUTS & RESULTS

i	8%
n	20 years
CRF	0.10185
Net Capital Cost*	$3,209,000
Net Annual Operating Cost*	$ 493,871
Consumption*	17,556,000 kWh
LCC Cogeneration	**$0.047 / kWh**
LCC Baseline**	**$0.063 / kWh**

* From Appendix C1.

** The marginal cost of new electricity to the end-user is assumed to be equal to the retail electricity rate (BC Hydro, 1994b).

Perspective: Building Owner / Energy System Developer

Appendix C1 contains the technical and cost assumptions for the economic evaluation of the cogeneration option from the perspective of a building owner who purchases the system and sells energy services to tenants or unit owners. The analysis is based on the following key assumptions:

- The electrical and thermal energy demand of the building is estimated using average figures for new high rise apartment buildings in BC (Marbek, 1993b).

- The cogeneration equipment is sized to meet the base electrical demand. The full electrical output is utilized, with roughly 65% recovery and utilization of heat.
- Net capital cost includes the capital and installation costs of the cogeneration equipment, back-up boilers, and plumbing the building for central heating, minus the capital costs of electric baseboard heaters, electric hot water tanks, peripherals and wiring. Electric and hot water metering are included.[32]
- Operating costs include: operation and maintenance, fuel, and stand-by and demand charges.
- Revenue calculations assume that all electricity produced is sold at the prevailing residential retail rate in New Westminster. The threshold value for heating services is assumed to be the avoided cost of electric heat; i.e., heat output is valued at the retail residential electricity rate[33].

Under the base case conditions, the project incurs net capital costs of $3.2 million over and above the business-as-usual system, and yields an internal rate of return of 22%[34] and a simple payback period of just over four years.

Many of the assumptions are surrounded by a considerable amount of uncertainty, owing to potential forthcoming changes in the regulatory environment. Therefore a number of scenarios were developed to reflect the possible range of values of those assumptions and their impact on the economic evaluation. The results are shown in Table 4.1. While the economics show that an opportunity exists under the base case conditions, changes in fuel and electricity prices as well as changes in regulatory requirements could result in significant growth in the market for distributed generation.

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[32] Equipment estimates are based on preliminary quotes from Jenbacher Energie/Inland Pacific Energy Services. Estimates for installation were provided by heating and electrical contractors based on square footage and number of towers.

[33] Note that this evaluation allocates all of the benefits of the project to the owner of the energy system, and none to the consumer. Alternative pricing assumptions would redistribute the benefits between system owner and consumer, but would not change the total value of the benefits.

Table 4.1 Scenario Summary

Scenario Summary						
		Base Case	Standby Chg	Fuel Cost	Elec Rate	Thermal Load
Changing Cells:						
Standby Charge	$/kVA	$ 56.00	$ 28.00	$ 56.00	$ 56.00	$ 56.00
Fuel Cost	$/mmBTU	$ 4.00	$ 4.00	$ 3.00	$ 4.00	$ 4.00
Electricity Rate	$/kWh	$ 0.063	$ 0.063	$ 0.063	$ 0.070	$ 0.063
Thermal Load	kWh	11,427,600	11,427,600	11,427,600	11,427,600	13,700,000
Result Cells:						
Cash Flow	$/year	$ 731,124	$ 759,124	$ 812,680	$ 871,211	$ 874,286
Net Present Value	$	$ 3,521,690	$ 3,770,672	$ 4,246,901	$ 4,767,373	$ 4,794,711
Internal Rate of Return	%	22%	23%	25%	27%	27%
Payback	Years	4.4	4.2	4.0	3.7	3.7

Notes to Table 4.1

1. Standby charges are currently at $56/kVA. This figure recognizes only the costs of distributed generation to the regulated utility, without considering any of the benefits. This situation is likely to come under review as the restructuring of electricity markets is considered. The above analysis shows the impact of halving the rate. In commercial applications, where the capital cost effect is lesser, the impact of changes to standby charges will be greater.
2. The change in fuel cost from $4 to $3/mmBTU reflects the possibility of purchasing natural gas at bulk rates and/or on an interruptible supply. Alternative fuels can be used in the backup boiler during peaks or outages.
3. The economic analysis is most sensitive to changes in the price of electricity. Rising electricity prices would suggest a growing market for cogeneration technologies.
4. If additional thermal loads were identified and incorporated into the site design through selective mixed use, the utilization of the waste heat generated by the system would be increased, with a resultant improvement in economic performance. The analysis shows the impact of a 20% increase in thermal load.

Environmental Impacts

The environmental benefits of the use of micro-cogeneration occur as a result of efficiency improvements over conventional equipment. The utilization of waste heat allows efficiencies of over 90%, compared with roughly 45% in a combined cycle gas turbine (CCGT; this technology is the state-of-the-art in conventional generation equipment). As one plausible baseline scenario to compare against, it can be assumed that all new electricity demand in the Lower Mainland will be served by CCGT technology. Thus, the proposed cogeneration unit (with backup boilers) displaces electricity that would otherwise be generated on the grid system using CCGT[35].

Table 4.2 summarizes the impact of the cogeneration unit on carbon dioxide emissions. Similar reductions are realized for nitrous oxides (NOx). If it is assumed that the cogeneration unit displaces generation in a CCGT plant located somewhere within the Lower Mainland, then it is not inconsistent with the GVRD's air quality objectives. Located elsewhere, decision makers may have to make difficult trade-offs between local and global energy and environmental objectives.

In the long term, the use of distributed generation technology may lead to other environmental benefits. Future energy supplies will most likely come from new technologies and fuel sources. Fuel cells, fueled by either natural gas or, ultimately, hydrogen are a likely candidate. Having the infrastructure in place to support these technologies could minimize the length of time before they become cost-effective alternatives. The development now of technologies and infrastructure that will ease a transition to cleaner technologies in the future is a benefit that is difficult to quantify, but nonetheless real.

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[35] BC Hydro's Electricity Plan suggests that this project might in fact displace a mix of combined cycle gas technology, other gas cogeneration, wood waste, small and medium hydro, and demand-side management. The simplifying assumption used here may slightly overstate the emission benefits.

Table 4.2 CO_2 Emissions Summary

Cogeneration Plant		
Capacity	kW	1000
Availability	%	98%
Fuel Rate	mmBTU/hr	9.5
Fuel Consumption	GJ/year	86,009
Electrical Energy Produced	kWh/year	8,584,800
Back-up Boiler		
Fuel Consumption	GJ/year	9,447
Electricity Displaced from other Sources		
Electricity Produced in Cogeneration	kWh/year	8,584,800
Building Thermal Load	kWh/year	11,427,600
Total Electricity Displaced	kWh/year	20,012,400
CO2 Accounting		
Emission Rate, Natural Gas	kg/GJ	50
Emission Rate, CCGT Plant	kg/kWh	0.380
Emissions, Cogeneration plant	kg/year	4,300,427
Emissions, Back-up boiler	kg/year	472,356
Emissions, CCGT Plant	kg/year	7,604,712
Net Reduction in CO2	**kg/year**	**2,831,929**
% Reduction	**%**	**37%**

4.2.3 Potential Barriers / Challenges

Regulatory Issues

In British Columbia, power producers who supply power for their own use or the use of tenants are not public utilities under the BC Utilities Commission Act, and therefore not subject to regulation (Section 1, BC Utilities Act). For small scale suppliers who want to sell electricity to the public within well-defined boundaries from distributed generation sources, it is relatively straightforward for the supplier to apply for exemption from regulation under Section 27 of the Act. Municipal utilities are, by definition, not public utilities, and thus not regulated by the Utilities Commission. Should the municipal utility wish to become a small scale generator, it would renegotiate its contract with BC Hydro to reflect its new status as such. Thus, it appears that the implementation alternatives suggested in Section 4.2.2 do not face insurmountable barriers with respect to regulatory requirements for the sale of heat and electricity services.

There is a concern that the absence of regulation for multiple small scale generators, including municipal utilities, has implications for the success of integrated resource planning in the energy sector as it is currently structured. For example, if such generators were exempt from the Utilities Commission Act, and given that they will fall beneath the threshold limits of the Environmental Assessment Act, the only remaining environmental regulatory jurisdiction for air quality is that of the Greater Vancouver Regional District. Currently, the only regulatory requirement in the GVRD is that emissions do not exceed those for the "Best Available Control Technology" for NOx emissions. Broader objectives such as resource portfolio optimization or CO_2 emission reductions appear to be at risk of slipping through the cracks. This issue will need to be addressed as the energy sector considers restructuring alternatives that may result in an increasingly competitive market place and an increased market share for distributed generation technologies.

Regulatory decisions of many kinds can significantly impact the profitability of small scale energy suppliers. Decisions about their eligibility for regulation and subsequent pricing controls, approval of stand-by charges imposed by electricity utilities for back-up electricity, and decisions about whether to impose obligations on utilities to provide for small scale producers to sell excess power back to the grid will all affect rate-of-return on investment. The uncertainty surrounding these issues in the current regulatory environment is a barrier to the entry of private service companies to the distributed generation market, and may cause them to demand a 20-40% rate of return for what is considered a risky investment. The resolution of these uncertainties is necessary if the market share of distributed technologies is to increase significantly.

Developer / Building Owner Issues

The current trend in large scale residential developments is overwhelmingly toward electrical resistance heating, primarily due to capital cost implications. Developers considering the installation of a micro-cogeneration system for heating and electricity services face significantly higher up front costs. In the Larco example, net capital costs for the cogeneration system are more than three million dollars greater than for conventional electrical resistance heating and hot water tanks. Because developers intend to pass on the operating costs to the consumer, there is little incentive to pay higher upfront capital costs in order to reduce the life-cycle cost of the energy services. In fact, similar experience with demand-side management investments suggests that even opportunities with a payback of two years or less will be rejected by developers on this basis. This "split incentive" between developer and owner is a market barrier that will have to be addressed if micro-cogeneration is to become more widely adopted in residential applications. The application of development cost charges is one mechanism for addressing this barrier which is discussed in Section 4.2.4.

In commercial developments, where the building owner more often expects to pay the ongoing operating and maintenance cost of the energy system, most developers install natural gas boilers and central heating systems because they are more cost-effective in the long run than electrical resistance heating. Then it is relatively simple to add the cogeneration facilities. Incremental costs are those of the cogeneration system only, and are partially offset by the avoided costs of boiler capacity. In addition, most commercial applications include air conditioning, and many have substantial thermal loads, each of which would improve waste heat utilization. Thus, large scale commercial developments represent a potentially easier market for cogeneration technology to penetrate than residential developments. That the technology has not penetrated to date can be attributed to two market barriers: lack of information (the lag between technology development and widespread awareness of the technology) and access to capital (choosing the most cost-effective technology is not an option if the required capital is not available).

Municipal Issues

Presented with an opportunity to improve the energy efficiency of a major residential development, the municipality of New Westminster is faced with potentially conflicting interests: the welfare of the community versus its own financial benefit. The business-as-usual design for the Larco development includes electrical resistance heating. Thus the municipal utility would realize a significant revenue stream from electricity sales once the development is complete. In order to determine the relative financial attractiveness of the two options from the perspective of the municipal utility, the business-as-usual case must be compared against the cogeneration case in a discounted cash flow analysis. However, since the assumption is that the value of the waste heat approaches the avoided cost of electric heat, the difference in the two cases can be minimized. That is, the difference in revenue will be based only on the extent to which the municipal utility opts to share the benefits of the system with consumers. The more significant factor is that the cost of the cogeneration system must be less than the bulk rate charged by BC Hydro. If this condition is not met, the municipal utility has no incentive to invest in something new. At current rates of 2.577c/kWh and demand charges of $4.41/kVA, this is an apparent barrier.

To some degree however, this barrier is one of perception and results from an incomplete consideration of system costs. The bulk rate charged by BC Hydro does not represent the true marginal cost to the municipal utility of electricity consumption and is an unfair benchmark against which to compare cogeneration options. In New Westminster, revenues from electricity sales are currently used to fund projects in other sectors - parks or other amenities. Instead, they should be set aside to fund future maintenance and expansion of the electricity distribution system. Because they are not, the utility may not be in a position to fund necessary works in the future. Depending on a variety of site-specific factors, new large electricity loads may impose significant system expansion and improvement costs. A move toward distributed generation technologies could help to offset future costs. When these costs and benefits are factored into the utility's financial analysis of alternative energy systems, the results may in fact be quite favorable.

The sensitivity analysis in Section 4.2.2 shows that the ratio of thermal to electrical load has an impact on the attractiveness of the project. The integration of commercial developments with residential developments has the potential to improve the economics of the project by evening out the load profile and thus the utilization of the installed equipment, including both heat and electricity[36]. Such a mixed use approach is also consistent with the municipal and regional policies on land use planning and transportation management outlined in Section 2.0. Thus standards or restrictions implemented in support of energy supply considerations do not create new limitations on community planning; rather, energy considerations provide yet one more rationale for a shift to more sustainable planning practices that are already justified on the basis of other community benefits.

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[36] Conversely, some types of commercial enterprises are net generators of heat. Such "waste heat" can be used for residential space heating in mixed use structures, but these types of enterprises would not improve the load profile for cogeneration applications.

Unfortunately, the municipal planning department and city council is generally under the perception that they do not have the legal authority to require developers to change their plans to meet energy objectives, nor do they have a strong negotiating position. This belief is a significant barrier that is addressed in Section 4.1.

4.2.4 Changing the Incentive System

The societal test suggests that there is an opportunity to deliver benefits through the adoption of a micro-cogeneration system at the Larco development. However it is also apparent that there are a number of barriers that prevent society from realizing those benefits. The development of economic and regulatory incentives will be necessary to improve the functioning of the market and facilitate the adoption of distributed generation technologies.

Incentives to the Developer / Building Owner

A sliding scale hook-up charge, not unlike municipal development cost charges, should be implemented by the regulated utilities and/or the municipal utility. Such charges must be based primarily on avoided cost, but consideration should be given to the need to provide a sufficient incentive for the developer to consider additional capital investment. In some cases, where it can be shown that there are additional societal benefits that have not been internalized into avoided costs, there may be justification either for higher charges or the provision of subsidies (by the utilities to developers) for preferred alternatives. Where a municipal utility is involved, they might also be collected under the umbrella of development cost charges. Development cost charges are currently authorized as charges to be levied against developers at the time of development for the purpose of recovering capital costs associated with sewage, water, drainage and highway facilities, as well as the provision of park land. It is a small step to expand them to include the provision of energy services. Such a direct pricing signal will send the message to developers that there are preferred technologies in existence that can be cost-effective in favorable applications. It will also help to remove the split incentive barrier.

If in fact the cogeneration system is better for consumers and society, the developer should be able to market the building on that basis. Significantly lower operating costs should increase demand for the units, and consumers might be willing to pay more per unit offsetting the developer's capital outlay. However, in order to be able to market a building on the basis of its energy attributes, the public must be able to recognize the energy and cost-saving attributes of the building. The adoption of a building labelling program would provide the necessary information to consumers and thus improve the functioning of the market. Again, experience with demand-side management initiatives suggests that labelling campaigns may enjoy only moderate success on their own, but may still be effective as part of an overall package of measures.

Incentives for the Municipal Utility

It is possible to envision a scenario where the municipal utility would be the lead agent in making the system a reality. However, there is a perception that moving away from electrical resistance heating will result in a loss of revenue to the utility. While the data suggest that this loss might in fact be offset by the additional revenue from heat sales, a detailed financial and technical analysis would be required to confirm this assumption. In any case, a small risk-averse utility is unlikely to act on the opportunity to invest in a new venture unless the benefits are substantially greater than the baseline. Changes to regulatory or pricing systems are possible ways to overcome this barrier. For example, the implementation of an increasing block structure for the tariff between the electricity producer and the distribution utility would have the effect of narrowing the profit margin of the distribution utility with increasing consumption.

There is an argument to be made that municipal utilities should be regulated. The rationale for exemption is that a municipal agency is mandated to provide services that are in the best interests of the community. In theory, there is no profit motive and the type of conflict of interest described above does not occur. However, in reality, in the face of rising municipal obligations and falling municipal resources, sales from electricity are seen as a major source of income. Regulation is one way of dealing with the apparent conflict. However, the economic and pricing incentives suggested above may serve the same purpose without the administrative burden of additional regulation.

General Regulatory Incentives

The sizing criteria used here are based on the current systems and regulatory environment for utilities. That is, no provision currently exists for such small scale suppliers to sell excess electricity back to the grid. Therefore systems today must be sized for baseload electricity requirements. From a thermodynamic perspective, systems are more likely to be optimized if they are sized based on thermal requirements (the units typically put out 40% electricity and 60% heat). If the opportunity existed to sell back excess power to the utility, equipment could be sized for thermal load, and off-sales of electricity would help to recover the costs of capital. Currently, this is possible, but there is no obligation on the part of the utilities to cooperate in facilitating such a system. Interestingly, where a municipal utility is involved, this type of arrangement can be implemented easily. However, municipal utilities are likely to lag behind the example of the regulated utilities due to the need for the development of technical standards for the interconnection of systems.

The economic calculation for the system is also sensitive to the rate of standby and demand charges. Reducing standby charges to half the current rate proposed with rate schedule 1884 has the effect of increasing the rate of return by 1%. It is significant to note that in commercial applications, the net initial investment is lower because the business-as-usual option is usually a central boiler system. Thus the effect of standby charges on economic performance will be significantly greater.

Future Potential

The regulatory environment with respect to electricity markets is currently dynamic. The BC Utilities Commission has undertaken a study of electricity markets which could result in changes to the regulations that create a market for surplus power and/or revisions to rate schedules for stand-by and demand charges. This would require the development of technical and administrative standards for system interconnections, however such developments are part of an emerging trend in electricity markets in North America.

What this means is that the potential for future applications of this technology is significant. The Larco development appears a likely candidate for a cost-effective installation based on its relative size and layout. It is not an ideal application in that it has relatively low thermal demand. With the negotiation of bulk gas rates, reduced stand-by charges, and the ability to sell electricity back to the utility at off peak rates, other applications which are currently marginal could become viable. Thus, the cost-effectiveness of the technology at the level of individual buildings is likely to be on the increase.

Section 5 IMPLICATIONS

Beyond the implementation of the policy packages as outlined in Section 2, this study suggests further areas where municipalities and regions, the provincial government, and energy utilities can take action, both unilaterally and cooperatively, to improve the prospects for community energy planning in BC. Areas requiring further study are also identified.

5.1 For Municipalities and Regions

Municipalities must take the lead role in implementing CEP. Their opportunity to realize benefits and their legal authority to take action have been established. However, there is a rationale for regional cooperation to create consistency across neighboring jurisdictions. Developers have concerns over the imposition of new standards and guidelines. Working with multiple planning departments on a project-by-project basis is onerous and expensive. The task of conforming to preferred standards of development will be made easier if standards and processes are consistent across jurisdictions. Municipalities and regions can help to minimize the burden on the development industry of a shift toward more energy-conscious design by working together to develop regional systems and standards.

Regional development standards

Multi-stakeholder groups, including representation from the development industry, utilities, municipal planning departments, municipal environment committees, and the community, should be formed to develop standards for new development. These should include an inventory of supply technologies that are to be considered for different types of developments, as well as building and community design measures to lower energy demand. Manuals of performance standards should be developed similar to those developed by the Ontario Ministries of Housing and Municipal Affairs (Marshall Macklin Monaghan Limited et. al., 1994). Different development classes might have different standards, and even within development classes, developers might be offered flexibility through a performance points allocation system (refer to Section 2.2.1).

Regional standards for development cost charges

Where a municipal utility is not involved, the regulated utilities should cooperate with municipal planning departments and regional growth management committees to set development cost charges that reflect different costs associated with different technology choices. Charges should be consistent across neighboring municipalities.

Regional standards for environmental review processes

These processes should include review of energy-related performance, should require the developer to show that reasonable alternatives were considered, and should establish fast-track approval processes for proposals that are proactive in meeting preferred standards of development.

Regional building rating and labelling system

Regional commitment to a mandatory labelling system[37] will improve consumer awareness of the energy performance of buildings and may improve the marketing opportunities for developers who feature energy-efficient design. A standard rating system may also facilitate the use of energy-efficiency mortgages, which take the energy bill of the home owner into consideration when setting mortgage terms.

Regional tax-base sharing agreements

Cooperative systems of tax-base sharing should be developed among neighboring communities that compete for development. In Minneapolis-St. Paul, municipalities are required to pool a portion of their commercial and industrial tax base (Roseland, 1992). These are then distributed throughout the metropolitan region according to each community's population and overall tax base. Many communities in BC are currently pressured into inappropriate development decisions by fiscal considerations and a fear that developers will simply move to a neighboring community if too many conditions are imposed. For such communities, a system of tax-base sharing could help to establish more sustainable patterns of land use.

[37] Examples include the Home Energy Rating System (HERS), widely in use in the US, and the Building Environmental Performance Assessment Criteria (BEPAC), developed at the UBC School of Architecture.

Regional Marketing Studies

Developers may be legitimately concerned about whether a market exists for infill, mixed use, pedestrian-oriented development, or energy efficient design. Regional working groups should initiate market studies, and based on the results, develop a marketing program to inform consumers, business, industry and residents about alternative lifestyles as well as about the costs and benefits of their lifestyle choices.

Community Development Objectives and Indicators

Communities and regions should explicitly state their long-term objectives and define measurable indicators to help them establish benchmarks and measure progress. Quantitative targets and the ability to measure progress create accountability, motivate policy and build community support.

Multi-Attribute Trade-off Analysis

While CEP offers potential benefits to communities and regions, the development of a CEP strategy will involve trade-offs. At the local level, there will be stakeholders who value conventional development (e.g., low-density, single-use subdivisions), and there will be times when alternative supply options will increase local employment at the expense of local air quality (e.g., wood utilization will increase emissions of nitrous oxides and/or particulate). Communities must establish formal processes for soliciting public input on objectives and values, and making explicit trade-offs among options.

Interdisciplinary Management Framework

Community energy planning creates benefits in a wide number of sectors, from transportation to liquid waste management. Narrow sectoral analyses are unlikely to identify all of the costs and benefits of alternative strategies. In order to justify taking action on CEP initiatives, it will be necessary to adopt a systems perspective that recognizes cross-sectoral benefits. This implies a new level of cooperation among traditionally highly segregated management lines, and requires that upper level managers have a truly interdisciplinary perspective.

5.2 For the Province

If CEP is to become a reality in British Columbia, the provincial government has a key role to play as a coordinator and catalyst to municipal action. Beyond a desire to further municipal objectives, the province should be motivated to support CEP as a means of meeting its own commitments and Canada's international commitments to greenhouse gas emission reduction. The following are some of the key considerations for the province with respect to supporting CEP.

Greenhouse Gas Stabilization Target

This study has two main findings with respect to the province's greenhouse gas stabilization target: (1) although the CEP measures as defined in this study are not sufficient to meet the province's stabilization target, they make a significant contribution toward that goal; (2) the abatement cost associated with changes to the urban form is in fact not a cost at all, but delivers substantial savings to the people and governments of BC. For the provincial government, this suggests that immediate support of community energy planning is a critical component of a sustainable energy strategy for the province.

Interpretation of the Growth Strategies Act

The Growth Strategies Act provides a legislated mandate for regions to address sustainability objectives. It explicitly states that a growth strategy should work toward planning for energy supply and promoting efficient use, conservation and alternative forms of energy. However, in practice, how this objective will be interpreted is quite uncertain given the lack of experience with planning for energy objectives at the municipal level. It will be important for the provincial government to ensure that the first communities/regions undergoing the growth strategies review process set a precedent for subsequent communities. The province must be proactive in assisting these pioneer communities/regions to develop tools and methods for community energy planning that will help to identify indicators, quantify benefits, and establish standards for development.

Municipal Geographic Information Systems

Without the use of Geographic Information Systems (GIS), it is difficult to make accurate assessments of density and mixed use characteristics at the neighborhood scale and, consequently, of the costs and benefits of specific CEP strategies. Not only will GIS allow communities to enter such data as density of development, type of development, employment type and distribution, and availability of transportation facilities, but it will allow communities to develop indicators to measure and track performance. This capability is important to motivate communities to undertake major initiatives. Unfortunately, very few communities have operational GIS systems. The provincial government should consider providing support for developing and populating municipal GIS systems as one means of supporting community energy planning in the province. This does not mean to suggest that CEP strategies should not be undertaken in the absence of GIS, only that measuring and tracking capability will be enhanced through its use.

Legislative Reform

Most CEP strategies can be conducted within the authority provided under current legislation. However, the following summarize some of the recommendations for legislative change that would help to ease the process of CEP in BC.

1. Amend the Municipal Act to:

- Include energy in Section 945.
- Expand the scope of conditions that local government can include in development permits and provide more enabling language to ensure compliance (Part 29 generally).
- Expand the range of applicability of development permits beyond specially designated areas (Section 976). Allow permits to apply to the particulars rather than just the general character of development, where those particulars can be shown to impact the policy objectives in an official community plan.
- Remove the barrier to withholding a building permit (Section 981) in the absence of an existing conflicting bylaw or plan in cases which involve environmental concerns

2. Amend the Land Title Act to:

- Include the need to provide adequate access by pedestrian and cycling accessways in addition to highways (Section 75).
- Clarify and expand the interpretation of the phrase "protection of the natural environment" (Section 85).

3. Pass new legislation concerning:

- Retrofit standards (MEMPR, in cooperation with the Building Standards Branch, Ministry of Municipal Affairs).
- Dedicated legislation for the regulation of vehicles and driving, including fleet requirements for alternative fuels and employee trip reduction programs for businesses over a certain threshold number of employees, the implementation of which might be delegated to local government (Ministry of Environment, Lands and Parks).
- Formalization of intergovernmental, interagency and intermunicipal partnerships in planning. This has occurred on paper through the passing of the Growth Strategies Act. However, the Act should be expanded beyond its current mandate to explicitly authorize local government to enforce standards and guidelines established by the regional growth strategy and mandate the involvement of the relevant provincial ministries, energy utilities, transit officials and the public, including developers. It must institutionalize a planning time horizon of not less than twenty years, and establish cost-sharing mechanisms among levels of government and among municipalities (Ministry of Municipal Affairs).
- Sample bylaws should be developed in cooperation with municipalities/regions to help clarify municipal authority with respect to building standards, vehicle regulation, etc..

4. Consider community energy planning in BC Utilities Commission rate hearings:

- Mandate the extension of Integrated Resource Planning guidelines to apply to planning processes based on the community and/or region as the fundamental planning unit, and requiring cooperative cost-sharing approaches to energy infrastructure planning.
- Mandate the adoption of sliding scale hook-up fees and other incentives to encourage the adoption of energy sources that are consistent with long-term planning objectives, and to discourage those that are not.

Intergovernmental and Inter-agency Partnerships

While legislative reform would improve the outlook for community energy planning, far more critical is the provision of technical and economic assistance. Municipalities, especially smaller ones, lack the technical resources necessary for energy analyses and the management of new energy supply initiatives. Partnerships with utilities and the relevant provincial ministries will be essential.

Assistance might take the form of funding for permanent community energy officers, having consultants or energy service companies hired by the ministry and rotated through municipalities, or seconding ministry staff to municipal governments to initiate programs. Further, many of the measures proposed, in spite of having lower life-cycle costs, require up-front capital. Once again, it will only be through partnerships with the provincial ministries and utilities that municipalities will be able and willing to finance new initiatives, many of which will be perceived as high risk.

5.3 For the Energy Utilities

At a minimum, the role of energy utilities is to provide technical expertise to communities undertaking CEP. However, CEP is really a logical extension of the Utilities Commission's existing guidelines for Integrated Resource Planning. Thus, utilities should recognize communities and/or regions as special planning units requiring the preparation of community energy plans in cooperation with the community. They should participate in and even lead the formation of working groups of utilities personnel, developers, transit officials, planners, and municipal engineers for the purpose of identifying options and removing barriers to the implementation of CEP strategies. Some specific recommendations follow.

Partnerships in the planning and delivery of services

Utilities should work with municipal planners to identify opportunities for joint planning and delivery of services. Examples include: creating logical zones for district heating or other energy supply alternatives; sharing distribution corridors and related construction costs for the delivery of services such as water, sewer, gas, or heat; and jointly implementing water and energy conservation measures. Synergies in planning and delivery are likely to create cost savings as well as service improvements for all agencies.

Development cost charges for new electricity hookups

Sliding-scale hook up charges, based primarily on the costs of alternative energy supply options, should be implemented to send the right price signal to developers about the life-cycle costs of development decisions, and to offset the initial capital cost differential associated with alternative supply systems.

Rate design for sales to municipal utilities

The implementation of an increasing block rate structure for the tariff between electricity producer and the distribution utility would have the effect of narrowing the profit margin of the distribution utility with increasing consumption, thus creating an incentive to invest in energy efficiency initiatives and new supply technologies.

Purchase of excess power from small scale power producers

The economics of small scale cogeneration facilities would be significantly improved if producers have the opportunity to sell excess power back to the utility. Then equipment could be sized for thermal load, improving capacity utilization, and off-sales of electricity would help to recover the costs of capital.

Review of stand-by and demand charges

Current rates for stand-by and demand charges to independent power producers (IPPs) reflect the costs to the utility of guaranteeing stand-by power in the event of an equipment outage. However, IPPs argue that the rates do not reflect any of the financial benefit gained by the utility as a result of the IPP's operation. Rates should be reviewed to ensure that they reflect all of the relevant costs and benefits.

5.4 For Further Study

The implementation of CEP could be improved by further studies to provide data and/or more detailed analysis of the benefits of CEP.

Indicators and Performance Targets

In order to set targets, make comparisons among communities, and track progress over time, there is a need to establish meaningful indicators and realistic performance targets for communities of various types. Density can be defined in many ways, as can mixed use and transit access. And there are clearly other indicators which would be useful in evaluating neighborhood sustainability (Appendix B5). Studies involving communities from across the province are needed to: (a) identify a diverse but manageable number of objectives and indicators; and (b) establish realistic performance targets. The existence of an agreement on a core set of indicators and performance targets would help to motivate and enable communities to begin a process of moving toward sustainability goals. Without an operational GIS, measuring and tracking indicators at a neighborhood scale may be extremely difficult. However, it is also possible to establish community-scale indicators such as overall per capita travel or per capita emissions to serve as an important first step.

Detailed GIS-based Case Study

The results of this study provide order-of-magnitude results and suggest that virtually all communities could benefit from a CEP approach to long-term planning. However, to improve the credibility of the CEP process, there is arguably a need for at least one BC-specific GIS-based study on CEP to confirm these results. The provincial government should consider sponsoring such a case study.

Tools and guides for planners and developers

Even more important than further study on the "why" of CEP, is further study on the "how". Comprehensive, flexible and accessible material on design standards for new development and redevelopment are necessary to empower municipal planners and engineers, and developers themselves, to begin designing sustainability into the urban form.

6.0 Conclusion

This study has defined community energy planning, evaluated its potential for delivering benefits in BC, and identified the means for implementing it. Specifically, it contributes the following key prerequisites to the adoption of CEP:

- a definition of the principles and practice of CEP;
- an order-of-magnitude estimate of costs and benefits to motivate communities and the province to take action;
- a heuristic or method of analysis for taking a community-specific strategy and extrapolating it to estimate aggregate effects;
- an understanding of the legal authority for municipal involvement in energy planning;
- a concrete example of implementing CEP;
- a clarification of the roles and responsibilities of different parties in implementing CEP.

The results of the study suggest that CEP has the potential to reduce energy-related greenhouse gas emissions, improve local employment, open up new business opportunities, and contribute to broad social objectives within the urban environment. It delivers these benefits to communities, utilities, and the provincial government. And it delivers them at net cost savings to society.

All community planning processes involve trade-offs and CEP is no exception. Local air quality and the maintenance of traditional neighborhoods are examples of objectives that may, under certain conditions, suffer under a CEP approach. However, as communities and utilities become increasingly aware of the need to address multiple objectives in planning, CEP offers decision makers a set of alternative strategies for meeting emerging priorities.

Municipalities must lead the initiative to implement CEP. Regional cooperation will facilitate many of the measures. The provincial government, in recognition that CEP is a cost-effective strategy for addressing energy-related greenhouse gas emissions, must ensure that municipal and regional action is taken, and provide technical and financial support. Partnerships with utilities, in recognition of opportunities to deliver new and more cost-effective services to ratepayers, will be a key strategy in implementation.

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APPENDIX A

MODELLING LOCAL EFFECTS

A1 Detailed Methodology
A2 CEP Case Studies and Results
A3 Modelling Assumptions and Output
A4 Community Energy Planning Guide

APPENDIX A1
Detailed Methodology

A1.1 BUILDINGS

Overview
Current residential building stock is established with data collected from the city planning department for the numbers of dwelling units. Some city offices have only limited data on commercial floorspace. Where local data was unavailable, it was estimated from the Conservation Potential Review data (Marbek, 1993).

Heating loads per housing type were calculated using averages from the CPR study. The non heating load is estimated by assuming that heating requirements make up 81% of all residential energy consumption (64% space heat plus 17% water heating). These estimates are used for all communities. BC Hydro regional data for Prince George was used to reference the average consumption of various housing types. These were found to be consistent with the CPR and other estimates for energy consumption per housing type in terms of relative intensities

The BAU and CEP scenarios are based on the same assumption for growth rate and the initial heating and non heating load is the same for each scenario.

Demand-Side Management
In the residential sector, the percentage of growth that is accommodated in each type of housing is input exogenously reflecting municipal policy. A resulting density effect is calculated which indicates the savings in energy that result from moving to an alternative mix of housing types. Only the heat energy saving is calculated.

In both residential and commercial sectors, it is assumed that all new buildings are constructed with consideration of passive solar and microclimate design features. Energy savings suggested in the literature range from 10-40% for passive solar and 5-15% for microclimate. At 10% and 5% respectively, the values used in this study are conservative. The penetration of solar hot water heating varies among community types, reflecting decreased cost-effectiveness as a result of local climatic considerations.

In the commercial sector, it is assumed that 40% of office and retail space are located in mixed use developments, and that 30% of the heat load of the affected commercial space is available as waste heat to the residential sector.

The savings due to conventional DSM in the BAU scenario is based on ISTUM[1] natural run simulations which indicate that an overall reduction in base energy intensity of 15% can be expected. This is split between general DSM (10%) and conversion efficiency improvements (4%). The CEP scenario assumes that through implementation of the policy packages, municipalities are successful in removing barriers to greater penetration, such that reductions in base energy intensity can be increased to 30%, or half of the economic potential as reported by the CPR I study and confirmed by the CPR II study findings (SRC, 1994).

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[1] Intra-Sectoral Technology Use Model: An energy end use model developed at Simon Fraser University that simulates consumer response to price and technology evolution.

Supply Calculations

For district heating systems, no detailed engineering calculations for optimization of plant sizing were performed; standard capacities at 10 megawatt increments were considered, with a standard heat to power ratio. The same is true for the proposed cogeneration plant from the combustion of biogas on sewage facilities. Surrey's multi-fueled power plant is taken directly from Moffat (1992). For heat pumps generally, penetration rate varies by climatic suitability, reflecting variability in coefficient of performance (efficiency) and hence cost-effectiveness.

The proportion of energy supplied by the grid and natural gas mains is calculated by splitting the remaining demand at the same relative share as the base and BAU scenarios. Transmission losses are not accounted for.

A1.2 TRANSPORTATION AND LAND USE

BAU assumes that all growth is accommodated in the peripheral residential developments, according to recent and projected trends. Average trip distance increases accordingly. In the CEP, 30% of growth is accommodated within redeveloped core areas, with the remaining 70% located in contiguous developments close to central facilities. Average trip distance declines accordingly.

Modal shift to HOV is based on a presumed increase in vehicle occupancy from 1.1 to 1.2 - 1.4 depending on the community. Number of household trips per day is based on the Energy Council's suggestion that this may be as high as 10 per household. The trend to rising auto dependence in BAU results in a slight rise, while in CEP a slight decline reflects modal shift toward transit and pedestrian/bicycling. Average distance is based on the weighted average distance to regional shops.

In the CEP scenario, alternative fuel vehicles are expected to penetrate to a level of 10% of all commuter and casual trips. No attempt is made to distinguish among the alternative fuels currently competing for shares in the emerging market. Instead, a composite is assumed, consisting of one third natural gas, one third propane, and one third electric. Increases in fuel efficiency are not considered.

Transit data is from BC Transit. Some communities will not experience enough growth to increase density sufficiently to meet currently accepted threshold density limits for cost effective transit, however it is assumed that through thè increased use of more innovative and flexible transit solutions, including small vans, taxi ride share programs etc., moderate modal share improvements could still be realized. The calculations assume that this increase will achieved by increasing transit frequency and also operating costs by four times. Clearly this is a simplified calculation which ignore the complexities involved in transit planning. "Across-the-board" frequency increases are likely to increase costs by a ratio of more than one to one. Instead, a cooperative effort between city and transit officials is required to identify key leverage routes. Most likely these will be in and around the mixed use nodes, and on selected peak hour express routes from viable residential areas.

A1.3 COST

The costs of supply technologies are calculated based on a life-cycle cost (LCC) analysis at a social discount rate of 7%. LCC for supply technologies in general does not include the end user's equipment cost, although for district heating, LCC does include connection costs. The implicit assumption is that equipment costs are roughly equal for all supply technologies.

Calculations are based on 1994 prices for relatively mature technologies (e.g., gas engines, heat pumps) and on forecasts for 2000 for those expected to undergo rapid development in the next few years (e.g., photovoltaics). For electricity from the grid and natural gas from gas mains, only the rate charged by the utility is used in calculating costs. The rate is assumed to be constant in real terms over the 15 year period, reflecting the current trend to converging marginal and average costs. (BC Hydro, 1994)(RCG, 1994).

Use of microclimate is assumed to be costless. This is true for lot orientations etc., but may not hold completely for the use of vegetation and landscaping. Increased density has a negative cost due to decreased cost of housing. The life-cycle costs of demand-side management measures are drawn from simulation runs of the ISTUM model at Simon Fraser University.

For local supply systems, LCC is calculated based on the standard formula:

$$LCC = \frac{CC\,(CRF) + \Sigma AC}{\text{Energy Output}}, \quad \text{where } CRF = \text{Capital Recovery Factor} = \frac{1}{1-(1+r)^{-n}}$$

CC = Capital Costs ($)
AC = Annual Costs ($)
r = Social Discount Rate (7%)
n = Technology Lifetime (years)

For cogeneration technologies, LCC is calculated as the average cost considering all energy output, i.e., (Total $) / (GJe + GJth). This is justified on the basis of a social cost analysis rather than a financial perspective.

A1.4 EMPLOYMENT INDICATORS

Employment effects accrue from two sources:

1. Direct, indirect and induced employment from investments in the energy sector.
2. Respending effects resulting from saving money on energy services, and spending it instead in areas of greater job intensity.

According to Sims (1991), investments in energy supply in BC generate roughly 3.3 jobs per million dollars invested. This includes direct, indirect and induced jobs. Demand-side management (DSM) technologies in the electricity sector generate roughly 13.6 jobs per million dollars. For this study, the 3.3 is assumed to apply to both major electricity grid and gas main investments and to local supply options. The 13.6 figure is applied to both electricity and gas DSM investments. After calculating the total annual cost of energy services for each of the BAU and CEP scenarios, the respending effect is found by multiplying the cost difference by the final demand multiplier of 12 jobs / $million, which assumes that savings are spent in typical consumer fashion.

Half of all jobs created as a result of expenditures in DSM are assumed to be created in the local economy. All of the jobs that result from investments in imported supply are assumed to be non-local. Half of all jobs from the "local" supply options are assumed to occur locally. All respending effects are assumed to result in employment in the local economy.

In Anahim Lake, it is recognized that fewer goods and services are available locally. Economic multipliers published by Davis (1986) for different regions in BC were used to scale down local effects accordingly. A factor of 0.8 was used reflecting the ratio of multipliers for the North region to the Lower Mainland region.

A1.5 MUNICIPAL ACCOUNTS

This calculation identifies opportunities for savings in operating costs as a result of community energy planning initiatives. It does not identify all effects; rather, it is a threshold analysis intended to show that enough savings exist that it is "worth doing anyway".

1. Municipally owned buildings. It is assumed that investments in energy efficiency reduce energy costs by 35-50% (Goldberger, 1993). Savings are based on identification of the number, square footage and current energy bills of municipally owned buildings.
2. Road Maintenance: This includes repaving and lane additions, but not new road construction. Savings are estimated by converting annual expenditures in 1994 to a dollar per kilometer figure, and comparing total kilometers of road expected in the BAU vs. CEP scenarios.
3. Snow Removal and Street Cleaning: As above.
4. Transit: Savings in transit expenses are based on increasing costs four fold, while achieving improvements in ridership. Ridership targets vary among communities. Transit savings are calculated only for Prince George and Castlegar. For Surrey, the integrated nature of the system made such analysis prohibitively complex.
5. Water and Wastewater Pumping Energy: This does not include efficiency measures in the pumping or treatment facilities themselves. It includes an estimation of savings that accrue as a result of the difference in urban form in the BAU vs. CEP scenarios. It is assumed that pumping energy is directly related to friction losses associated with additional pipe length. While this may be somewhat generous, no account is taken of the costs associated with the construction of additional lift and valve stations, so the estimation remains conservative.
6. Power Plant Revenue: For wood waste this is calculated based on the model developed for the BC Energy Council's Wood Utilization Project. Revenue is calculated net of taxes and interest payments. Electricity is assumed to be sold at \$0.056/kwh, which represents an approximate average of electricity sold locally at \$0.063/kwh locally and excess electricity sold back to the utility at \$0.04/kwh. Heat services are assumed to be sold at a rate equal to the rate paid by customers receiving heat services from natural gas. Only one half of available heat is sold in the Castlegar scenario for lack of customers. Surrey's multi-fueled power plant is taken directly from Moffat (1992) which calculates revenue based on an assumption that natural gas will be purchased at the bulk rate and sold to customers at retail rates.
7. Reductions in lot servicing costs are based on Frank (1989).

Program implementation costs are largely outside the scope of this study, however some general assumptions can be made. The process of rezoning land uses is assumed to be costless, as are additions to existing approval processes. Taxes and tolls are suggested in the policy packages, but not quantified due to the need for detailed study. Nor are capital costs of bicycle paths and pedestrian walkways explicitly calculated, however it is assumed that they are more than compensated by decreased expenditures in road construction.

APPENDIX A2
CEP Case Studies and Results

A2.1 City of Prince George

Community Profile
Prince George is a resource based community that has grown into a major regional service centre in the north of the province. Population in 1994 is roughly 72,000 and is expected to grow by 1.2-1.5 % per year over the next 10-20 years. With three pulp mills and 15 sawmills, the economy is said to revolve around "wooden dollars". The forestry industry directly employs over 6500 people with a further 16,000 employed in forestry-related service jobs. Other significant employers include chemical plants and the new University of Northern BC.

Energy Profile
The city and surrounding area currently depend on imported resources for virtually 100% of energy requirements. In the building sector, energy comes from the electricity grid and natural gas mains, and in the transportation sector, gasoline dominates. A small and declining percentage of light fuel oil, propane and wood heating systems are employed in the building sector but are considered negligible in this study. There are significant sources of wood waste in the Prince George region, as well as a Phase I[1] beehive burner, indicating that the potential exists to utilize wood waste for a community energy system. The city is subjected to severe winter conditions over eight months of the year.

Urban Form
Prince George is a low density community. The large remaining undeveloped area within city limits leads to a perception that land is unlimited and there is little public support for increasing density or urbanization. This suggests that in a business-as-usual scenario, Prince George's growth pattern is likely to follow that of typical urban sprawl, with increasing dependence on the private automobile for transport.

A Business-as-Usual Future
Typical single family oriented residential subdivisions continue to open up in the southwest and north sections of the city in spite of increasing costs to the town for servicing and maintaining such non-contiguous development. Single family homes represent 70% of all new dwellings constructed, street orientations are increasingly trending toward curvilinear streets and cul de sacs, and no consideration is given in laying out lot orientation to optimize solar gain. Of the multifamily homes constructed, the majority are constructed with electric baseboard heating units which decrease the economic potential for district heating in the future. Overall urban density continues to decline, dropping off to less than 8 people per hectare by 2010.

The downtown revitalization project is limited to a short stretch of 3rd Avenue. The private automobile continues to be the main mode of transport to and from the downtown core. In fact the access provided for pedestrians becomes the source of conflict as traffic increases over time and there is pressure to widen the roadway. By 2010 increasing traffic on the Highway 97 bypass has created congestion on the north-south connector and a conflict builds between commuters and

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[1] Phase I burners are those that must be phased out by December 1995.

highways planners who want to expand the capacity at a cost of several million dollars, and neighboring landowners who do not want more traffic, noise and smog in their area. There are demands for multi-million dollar overpasses at the 5th and 15th avenue interchanges.

A Future with Community Energy Planning

The downtown revitalization project begins with the redevelopment of 3rd Avenue, but it is complemented by an aggressive strategy to encourage redevelopment throughout the downtown core. A revenue-neutral differential taxation structure which taxes land heavily relative to buildings has the effect of making it very expensive to keep vacant land within the core area, and encourages vertical expansion. The abundance of one and two-level buildings downtown in 1994 is gradually converted into three and four level mixed use structures, through the provision of low interest loans and multiple incentive packages. Comprehensive development contracts governed by a performance point system[2], are negotiated with developers to ensure that residential, commercial, cultural, recreational and transportation services are all integrated into plans from the beginning.

While most of the growth in the next fifteen years is accommodated within the valley bottom area, it is recognized that a market remains for a more rurally oriented type of lifestyle. In an effort to accommodate this demand without incurring undue environmental or financial costs, the city opens up the Harper Valley area to development. The area is located near the downtown core, along a major transit corridor. The central feature of the development is a clustered residential development, nestled in a partially forested environment with access to a large natural open space. Two and three level units with heavily insulated shared walls, gables, sloped roofing, chimneys, courtyards, offset entrances and professional landscaping provide the best in energy efficiency while still protecting individual privacy and aesthetics.

Overall growth is accommodated as outlined in section 3.1.1. Increased traffic pressures on the main north-south connector are accommodated by turning one lane into an HOV lane during peak hours. Transit priority traffic signals are provided at congestion locations. Any additional road construction takes the form of addition of cycling lanes, bike racks, and wider sidewalks. Street trees and furniture in mixed use nodes and along strategic connectors help encourage pedestrian traffic. The costs of such measures are more than offset by reduced expenditures on conventional road maintenance and construction.

A large percentage of the work force in Prince George is employed by a few large employers. Thus, requiring that all businesses employing 50 or more employees institute an Employee Trip Reduction Program will affect a significant number of commuters. Because of the cold climate and consequent limitations on walking, cycling and transit as options, the emphasis is on increasing vehicle occupancy. However, in the valley bottom, transit remains a viable option, and the frequency of transit service in the valley bottom and along commuter routes is increased by four times, with a more flexible fleet makeup.

Site and building design measures follow those outlined in the policy package section 2.2.3.

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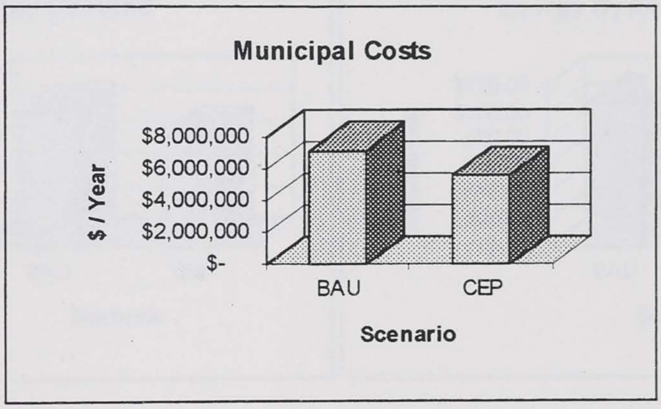
2 A portfolio of preferred characteristics of the development are itemized, with points allocated to each. Examples include bus shelters, bike paths, reduced street widths, some threshold amount of greenspace, passive solar design in buildings, etc. Development proposals must receive a minimum number of points before approval of the project.

After December 1998, there is an abundance of wood waste available that can no longer be incinerated in beehive burners according to provincial regulation, and sawmills are willing to pay to have their waste removed. Wood waste thus becomes the energy source for a combined heat and power plant established under the jurisdiction of a municipal utility. A district heating zone is established per section 2.2.4.

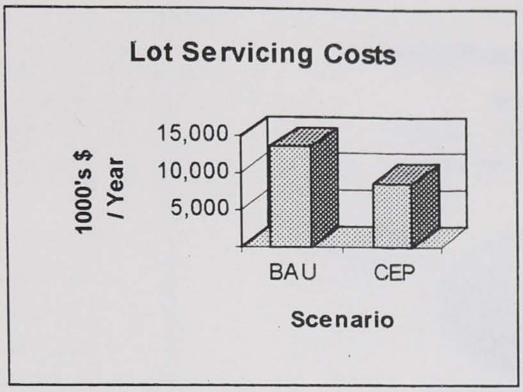
Results

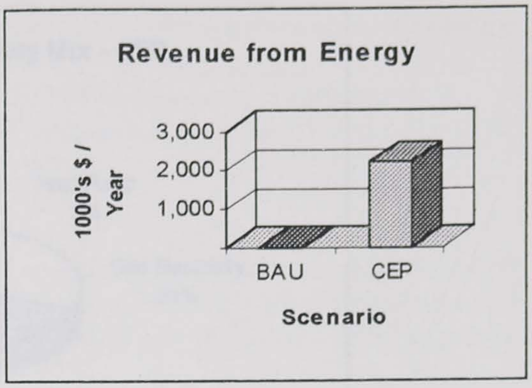
A Municipal Perspective
Savings in municipal operating budgets in the CEP scenario amount to over $1.5 million annually. These are realized as a result of reductions in building energy costs, fleet fuel costs, net transit costs, road construction and maintenance, and the pumping costs of water and wastewater systems. Transit operating costs increase threefold, however increased revenue from increased ridership goes directly to offset the municipality's share of the cost, with a net decrease in the municipality's cost. The quantified costs represent only a small portion of actual savings that might be achieved. Substantial savings could also be expected from reductions in the costs associated with road accidents, policing, and fire protection services. As well, it can be expected that increased expenditures on facilities for walking, cycling and transit would be more than offset by decreases in road infrastructure costs.



The actual costs of new infrastructure are in some cases borne by the municipality and in some borne by the developer. In the latter case, these costs do not directly affect municipal budgets, however, they are passed on to the home buyer. So it is significant to note that in the community energy planning scenario, savings in lot servicing costs of at least 30% will be achieved, amounting to roughly $4.9 million annually in 2010.

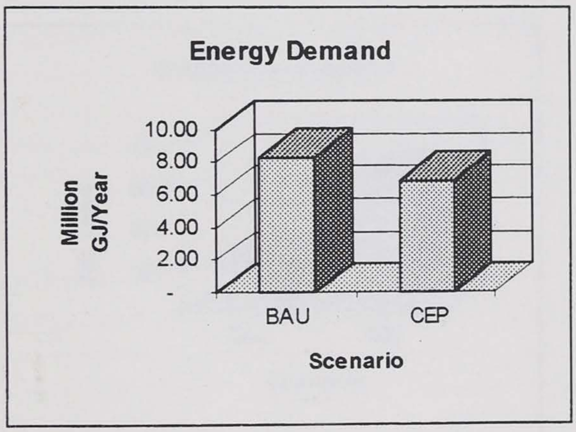
The sale of energy services by a municipally owned utility results in net income, after tax and after interest payments, of roughly $2.2 million per year. Revenue from taxes on fuels are excluded under the assumption that a municipal franchise tax on district heat will be calculated to replace lost revenue from existing taxes on other fuels. The analysis assumes that excess electricity is purchased by the BC Hydro, and that wood waste is available at a credit to the municipality as sawmills are willing to pay for disposal.

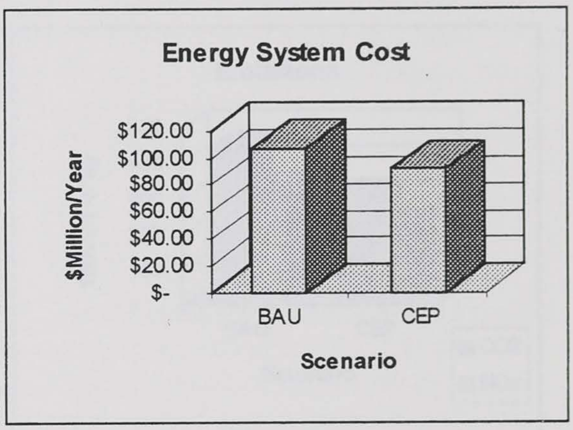




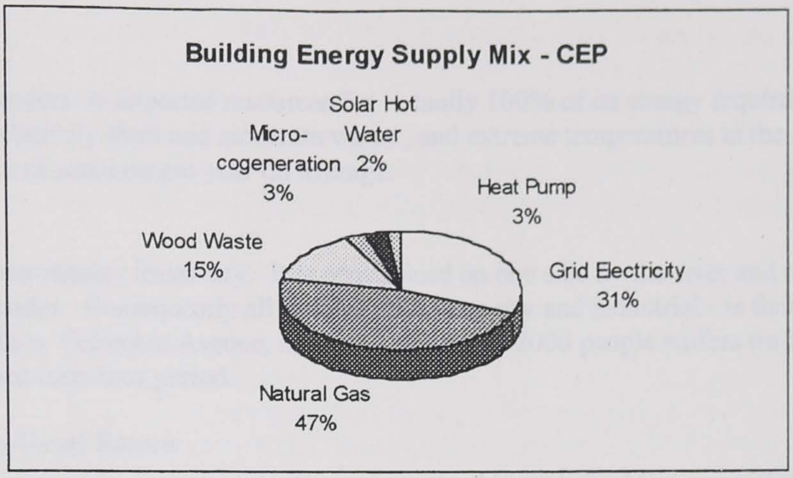
A Community Perspective

Dramatic reductions in energy consumption are achieved as a result of increased conservation efforts, use of passive solar and microclimate, use of more efficient energy conversion technologies, and the utilization of waste heat in mixed use developments. Consumption relative to the business-as-usual scenario is roughly 17% lower. The total cost of energy services is 15% lower than that in the business-as-usual scenario. This represents over $15 million annually.



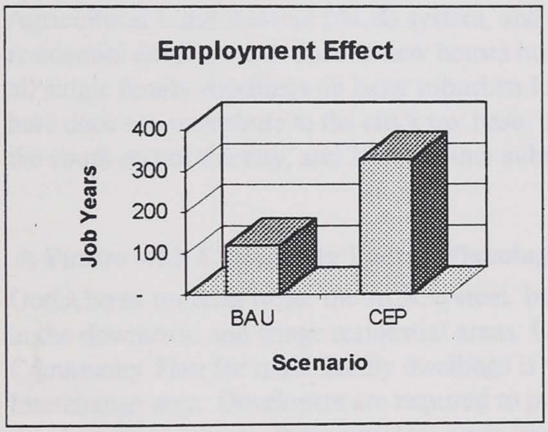


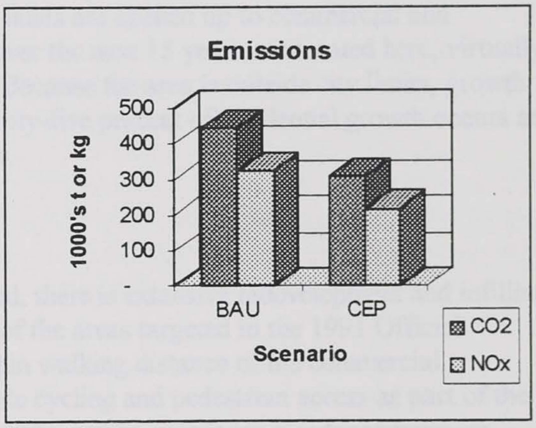
In the CEP scenario, over 20% of all building energy is provided through local supply sources (heat pumps, micro-cogeneration, solar hot water and wood waste). In BAU, all building energy is provided from the grid and natural gas mains.



23% Local Supply

Investments in efficiency and local energy resources tend to create jobs locally. Investments in the energy system in 2010 create nearly twice as many local jobs in the community energy planning scenario relative to business-as-usual. Much of this employment is created as a result of investments in local energy resources.





Community energy planning dramatically reduces emissions of carbon dioxide and nitrous oxides in 2010 - over 30% reduction. For nitrous oxides, this assumes that the wood waste plant displaces a beehive burner. If it did not, nitrous oxides would rise slightly in the CEP scenario.

A2.2 City of Castlegar

Community Profile
The city of Castlegar is located in the southern interior of BC, midway between Vancouver and Calgary. It is the focal point of three major highways: No. 3, 3A and 22. It is a hub of timber operations in southeastern BC, with the forest products industry directly employing over 700 people. Centrally located in the West Kootenay, Castlegar is growing in importance as a regional warehousing, distribution and servicing centre. Today the population within the urban limits of Castlegar is roughly 7000, reaching 15,000 in the surrounding district. While growth stagnated through the eighties, it is expected to rise to 2.5% to 3% per year as Lower Mainland growth pressures overflow into the region.

Energy Profile

The city is dependent on imported resources for virtually 100% of its energy requirements. It experiences a relatively short and moderate winter, and extreme temperatures in the summer, with over 1800 hours of sunshine per year on average.

Urban Form

Castlegar is a low density linear city. It is constrained on one side by the river and on the other by steep mountainsides. Consequently all traffic - city, inter city and industrial - is funneled onto one main thoroughfare, Columbia Avenue, and this city of only 7000 people suffers traffic congestion over a significant rush hour period.

A Business-as-Usual Future

In response to increased congestion, the City, in partnership with the Ministry of Transportation and Highways, expands the width of Columbia Avenue at a cost of $4.5 million dollars to the City and $14.0 million for Highways. A further collector road is constructed at a cost to the City of $2.7 million.

The Central Kootenay Regional District succeeds in having Ootischenia (a large flat area on the opposite side of the river currently outside the city limits of Castlegar) removed from the Agricultural Land Reserve (ALR) system, and the lands are opened up to commercial and residential development. Half of new homes built over the next 15 years are located here, virtually all single family dwellings on large suburban lots. Because the area is outside city limits, growth here does not contribute to the city's tax base. Twenty-five percent of residential growth occurs at the south end of the city, and 25% in other suburbs.

A Future with Community Energy Planning

Ootischenia remains under the ALR system. Instead, there is extensive redevelopment and infilling in the downtown and fringe residential areas. One of the areas targeted in the 1991 Official Community Plan for multi-family dwellings is within walking distance of the commercial Interchange area. Developers are required to provide cycling and pedestrian access as part of the development contract. Differential taxation (increased taxes on vacant land, reduced taxes on buildings), financial mechanisms (low interest loans) and other incentives succeed in facilitating the subdivision of existing over-size lots in other areas. Thirty percent of all new residential and commercial growth occurs in the downtown and fringe area. One and two level buildings are converted to multi-story mixed use structures.

At the south end of town, a comprehensive development contract is negotiated with the developers such that they must incorporate both residential and commercial uses in an aesthetically pleasing manner, provide cycling and pedestrian access, and include energy efficiency measures in the site design -- including passive solar and use of microclimate. Streets are laid out in a grid pattern for improved access, with wider sidewalks and traffic calming features. Lots sizes are reduced by reducing the set back from the street. Clustered single family dwellings, creatively designed to maintain neighborhood character and individual privacy, reduce lot servicing costs and energy consumption, increase available greenspace and help to foster a sense of community.

One lane on Columbia Avenue is a dedicated HOV lane during peak hours. No increases in street width are undertaken, except to improve cycling and pedestrian access. Cycling facilities along Arrow Lakes Road are provided, serving two of the city's larger employers. All businesses employing 50 or more employees are mandated to institute an Employee Trip Reduction Program. This is assumed to affect roughly 50% of commuters, including over 300 who commute 27 km to Cominco in Trail. This is phased in, beginning with businesses with over 100 employees initially.

The existing transit fleet is augmented with smaller, more fuel efficient and flexible vehicles. Transit frequency is increased by four times, and coupled with express routes and HOV lanes, transit becomes the most efficient way to travel to the downtown area. Park and Ride facilities are provided for intercity traffic. Neighboring municipalities -- namely the Castlegar-Trail-Nelson triangle -- recognize the parallels between the distances and travel patterns among their communities and those among some of the Lower Mainland communities. This recognition sets the stage for planning for intercity transit catering to commuters and shoppers in the years to come. The distances involved are not unlike those between Vancouver-Surrey-Abbotsford. Thus over perhaps a 20-30 year planning period, it is not unrealistic to envision a time when inter-community transit is viable and preferable.

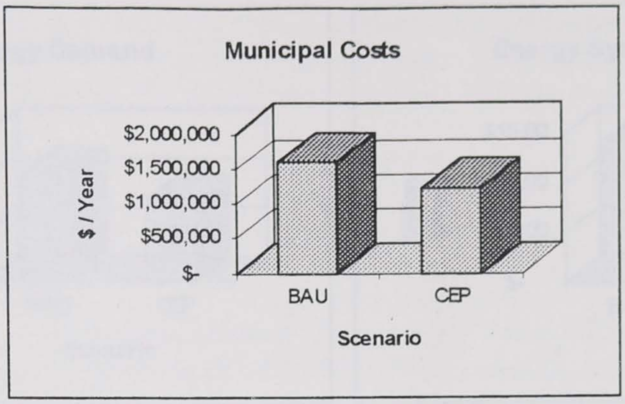
The site and building design measures proposed for Castlegar are as defined in section 2.2.3. An emphasis is placed on programs that encourage heat pumps and solar hot water heaters.

The city creates a district energy zone which encompasses those neighborhoods considered for ultimate inclusion in a district energy system - namely the "Transition" and "Special Residential" zones near the Interchange area. Special measures for density, diversity, rate of growth and site standards are applied. By 2010, a combined heat and power plant is established under the jurisdiction of a municipal utility, which provides district heating services and electricity to local homes and businesses and sells excess power to West Kootenay Power. The plant is fueled by local wood waste, available at a credit to the local utility as a result of provincial regulations requiring phase out of beehive burners and appropriate disposal of wood waste by 1998.

Results

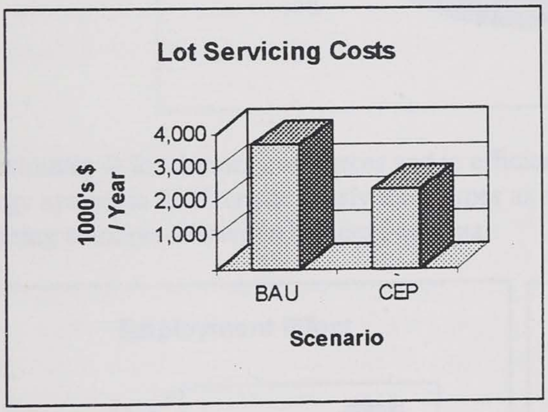
A Municipal Perspective

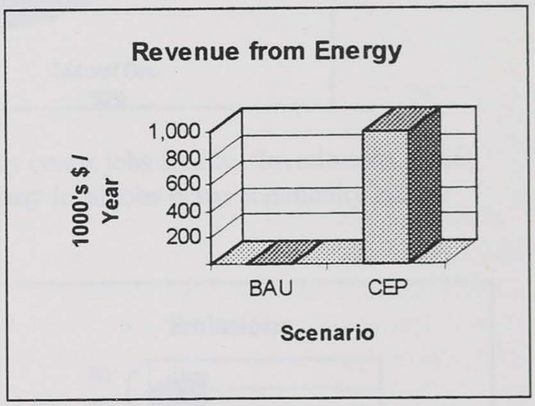
Savings in municipal operating budgets are nearly $400,000 per year. They are realized as a result of reductions in building energy costs, fleet fuel costs, net transit costs, road construction and maintenance, and the pumping costs of water and wastewater systems. These represent only a small portion of actual savings that might be achieved. Substantial savings could also be expected from reductions in the costs associated with road accidents, policing, and fire protection services. As well, it can be expected that increased expenditures on facilities for walking, cycling and transit would be more than offset by decreases in road infrastructure costs.



The actual costs of new infrastructure are in some cases borne by the municipality and in some borne by the developer. In the latter case, these costs do not directly affect municipal budgets, however, they are passed on to the home buyer. So it is significant to note that in the community energy planning scenario, savings in lot servicing costs of at least 30% will be achieved, amounting to roughly $1.3 million annually in 2010.

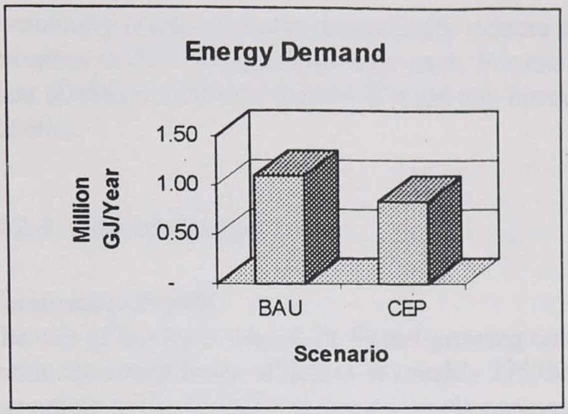
The sale of energy services from a municipally owned utility results in net income, after tax and after interest payments, of nearly $1.0 million per year. Revenue from taxes on fuels are excluded under the assumption that a municipal franchise tax on district heat will be calculated to replace lost revenue from existing taxes on other fuels. This assumes that the city is able to attract at least one large heat customer, in addition to expected residential and commercial customers, to purchase up to one quarter of the available heat. Without that customer, revenue would drop off significantly, but remain positive.

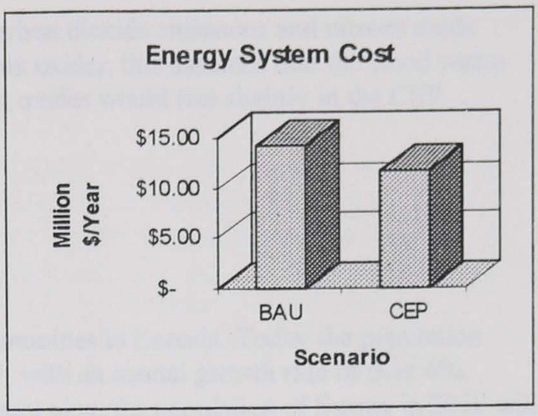




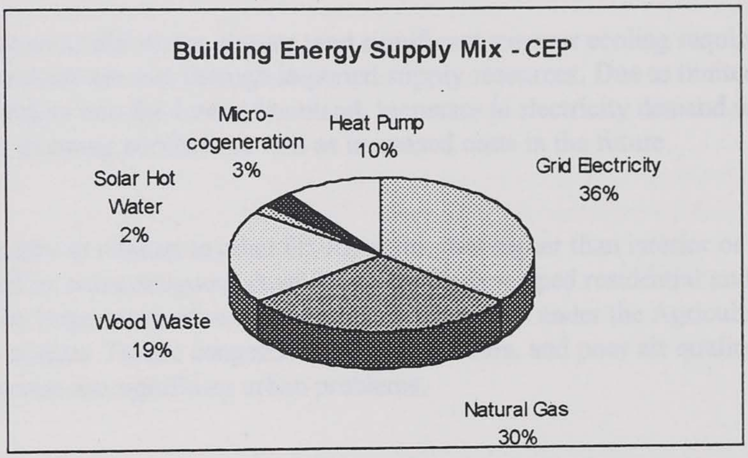
A Community Perspective

Dramatic reductions in energy consumption are achieved as a result of increased conservation efforts, use of passive solar and microclimate, use of more efficient energy conversion technologies, and the utilization of waste heat in mixed use developments. The total cost of energy services in 2010 is 18% lower in the CEP scenario relative to the BAU scenario, representing savings of roughly $2.6 million annually. This is achieved on a reduction in energy consumption of 23%.

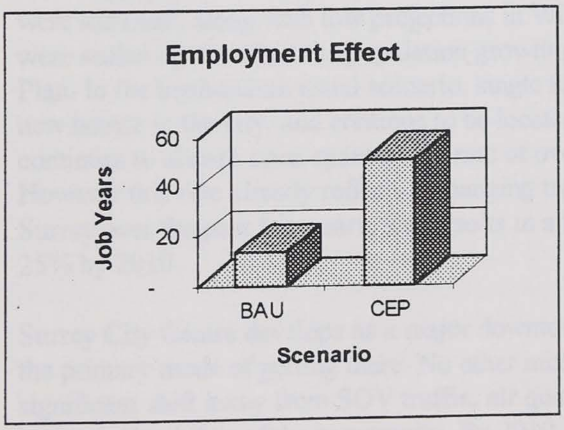


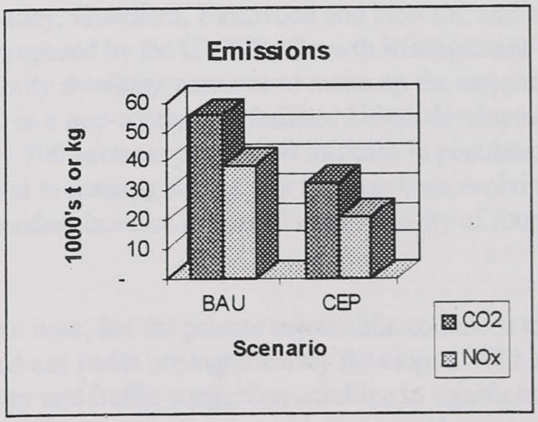


In the CEP scenario, over one third of all building energy is provided through local supply sources (heat pumps, micro-cogeneration, solar hot water and wood waste). In BAU, all building energy is provided from the grid and natural gas mains.



Investments in local energy resources and in efficiency create jobs locally. Investments in the energy system in 2010 create nearly three times as many local jobs in the community energy planning scenario relative to business-as-usual.





Community energy planning dramatically reduces carbon dioxide emissions and nitrous oxide emissions in 2010 - roughly 40% for each. For nitrous oxides, this assumes that the wood waste plant displaces a beehive burner. If it did not, nitrous oxides would rise slightly in the CEP scenario.

A2.3 City of Surrey

Community Profile

The city of Surrey is one of the fastest growing communities in Canada. Today the population within the urban limits of Surrey is roughly 275,000, with an annual growth rate of over 4%. According to the GVRD's regional growth management plan, the population of Surrey in 2010 will be in the order of 650,000. In relation to other GVRD cities, Surrey is comparatively underdeveloped in the commercial and industrial sectors, however it has land available for such development.

Energy Profile

The city experiences a mild winter climate, and significant summer cooling requirements. Virtually all energy requirements are met through imported supply resources. Due to limited access to transmission corridors into the Lower Mainland, increases in electricity demand are likely to cause difficult land use planning conflicts as well as increased costs in the future.

Urban Form

Surrey is low density in relation to other GVRD cities, but higher than interior or northern cities. It is characterized by non-contiguous development, with developed residential and commercial areas separated by large tracts of undeveloped land, some of it under the Agricultural Land Reserve (ALR) system. Traffic congestion in the peak hours, and poor air quality as a result of automobile emissions are significant urban problems.

A Business-As-Usual Future

A multiplicity of planning alternatives are currently on the table in the city planning department. For the purposes of this study, the city's high growth projections for South Surrey and Cloverdale were assumed, along with low projections in Whalley, Guildford, Fleetwood and Newton, and all were scaled up to reflect the population growth proposed by the GVRD's Growth Management Plan. In the business-as-usual scenario, single family dwellings continue to make up the majority of new homes in the city, and continue to be located in a non-contiguous fashion. Urban development continues to absorb open space at the rate of over 200 hectares per 12,000 increase in population. However this rate already reflects a changing trend in housing and lot size that has been evolving in Surrey over the past few years, and results in a modest increase in overall urban density of roughly 25% by 2010.

Surrey City Centre develops as a major downtown core, but the private automobile continues to be the primary mode of getting there. No other mixed use nodes are significantly developed. With no significant shift away from SOV traffic, air quality and traffic congestion combine to significantly lower the livability of the community. By 2010, conflicts arise over transmission corridor rights, as Lower Mainland electricity demand exceeds the capacity of existing transmission lines.

A Future with Community Energy Planning

The original plans for Surrey City Centre are complemented by increased emphasis on mixed use, transit, pedestrian and bicycle access, and local supply. Significant sources of heat and energy are identified, and a district heating zone is established. Outside the downtown core, two areas in Fleetwood and Newton are also targeted for intensive redevelopment and infilling, with an emphasis on the creation of smaller, moderate density, mixed use nodes. One and two level buildings are converted to multi-story mixed use structures. Thirty percent of all growth is accommodated in and around these mixed use areas.

Comprehensive development contracts are negotiated with the developers such that they must incorporate both residential and commercial uses in an aesthetically pleasing manner, provide extensive and continuous cycling and pedestrian access, provide wider sidewalks and traffic calming features, design for efficient transit access, and include energy efficiency measures in the site design, including residential clusters, passive solar design and use of microclimate. Lots sizes are reduced by reducing the set back from the street. Clustered single family dwellings, creatively designed to maintain neighborhood character and individual privacy, reduce lot servicing costs and energy consumption, increase available greenspace, and help to foster a sense of community.

No new increases in SOV capacity are provided. Traffic congestion problems are dealt with by the designation of HOV lanes and by imposing tolls on high use connectors and bridges. No increases in street width are undertaken, except to improve cycling and pedestrian access. All businesses employing 50 or more employees are mandated to institute an Employee Trip Reduction Program. The program is phased in, beginning with businesses with over 100 employees initially. Parking charges are instituted where they do not exist and increased by at least 50% where they do. A sliding pay scale encourages HOV's.

The existing transit fleet is augmented by smaller, more fuel efficient and flexible vehicles for low-density areas. Coupled with express routes, transit priority signals and HOV lanes, transit becomes the most efficient way to travel to mixed use nodes. Park-and-ride facilities are provided for intercity traffic. Savings in road construction are reallocated to transit, park-and-ride and cycling facilities.

The site and building design measures proposed are as outlined in section 2.2.3. Greater emphasis is placed on programs that encourage heat pumps and solar hot water heaters, and solar photovoltaics. An office of technology assessment and financial assistance for renewable technologies such as solar, wind and heat pumps is established to assist homeowners and businesses to overcome the barriers associated with new technologies.

The city creates a district energy zone which encompasses Surrey City Centre. Special measures for density, diversity, rate of growth and site standards are applied. A combined heat and power plant is established under the jurisdiction of a municipal utility, which provides district heating and cooling services and electricity to local homes and businesses, and sells excess power to BC Hydro. The plant is fueled by multiple sources including local wood waste (15%), natural gas (40%), river cooling, 10%, industrial waste heat (22%) and a heat pump on city sewage (15%) (Moffat, 1992).

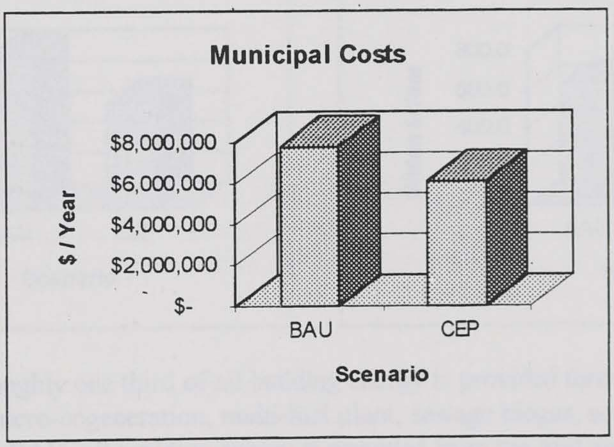
A second district energy zone is set up northwest of Surrey City Centre. A 5 megawatt cogeneration plant with district heating is constructed on the Annacis Island sewage treatment facilities to serve the area. Planners may look for opportunities to site an industrial heat source on the route to boost hot water temperatures for future expansion.

The city works in partnership with BC Hydro to establish a solar "village", which incorporates buildings designed from the ground up to accommodate roof-top solar panels, including optimal roof pitch and solar access, as well as maintenance access and connections to the electricity grid. The system benefits the utility by providing an alternative to costly additions to transmission capacity, and it benefits the community by providing an environmentally benign energy source and preserving green space that would otherwise be compromised by transmission corridors.

Results

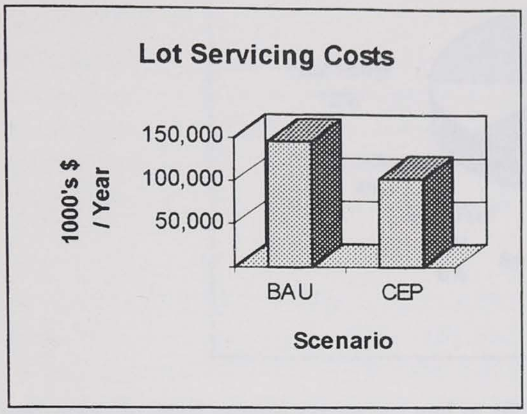
A Municipal Perspective

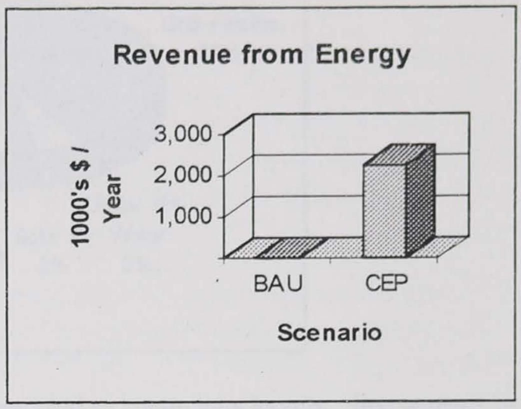
In the CEP scenario, savings in municipal operating budgets of roughly $2 million are identified. The savings are realized as a result of reductions in building energy costs, fleet fuel costs, road construction and maintenance, and the pumping costs of water and wastewater systems. However, this is clearly an underestimation. Fleet figures for example were available for passenger vehicles only, and building energy expenses appear much too low, suggesting that not all were identified. Due to the complexity of the integrated transit system, transit ridership improvements were not considered. The quantified costs represent only a small portion of actual savings that might be achieved. Substantial savings could also be expected from reductions in the costs associated with road accidents, policing, and fire protection services.



The actual costs of new infrastructure are in some cases borne by the municipality and in some borne by the developer. In the latter case, these costs do not directly affect municipal budgets, however, they are passed on to the home buyer. So it is significant to note that in the community energy planning scenario, savings in lot servicing costs of at least 30% will be achieved, amounting to over $43 million annually in 2010.

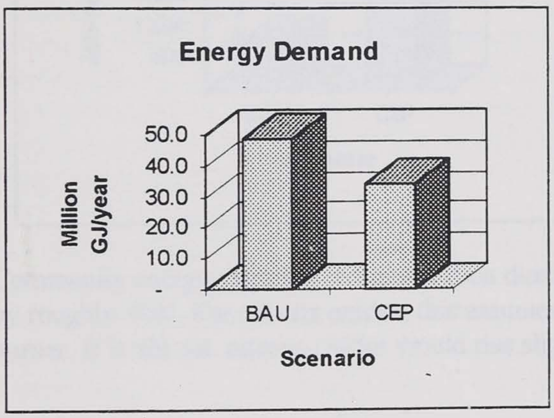
The sale of energy services from a municipally owned utility results in net income, after tax and after interest payments, of roughly $2.2 million per year (Moffat, 1992). Revenue from taxes on fuels are excluded under the assumption that a municipal franchise tax on district heat will be calculated to replace lost revenue from existing taxes on other fuels.

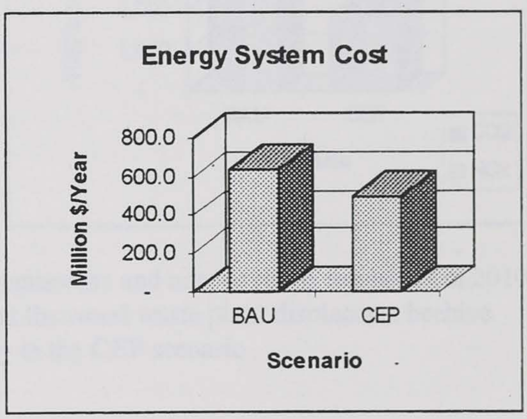




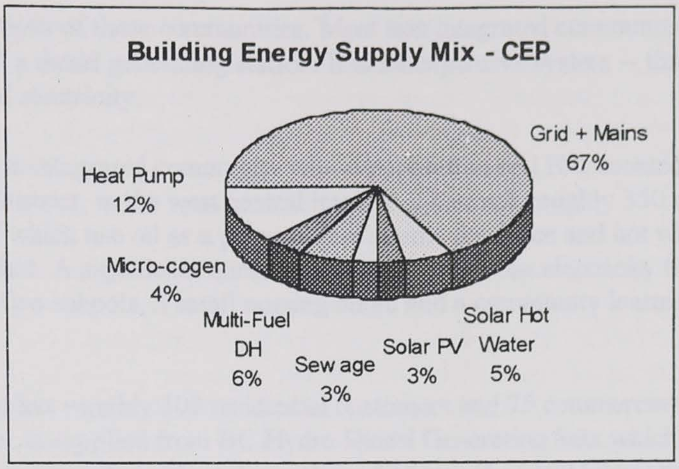
A Community Perspective

Dramatic reductions in energy consumption are achieved as a result of increased conservation efforts, use of passive solar and microclimate, use of more efficient energy conversion technologies, and the utilization of waste heat in mixed use developments. Energy consumption in CEP relative to BAU is nearly 30% lower, and the total cost of energy services is reduced by 22%. This represents over $138 million annually, or roughly $250 per capita.

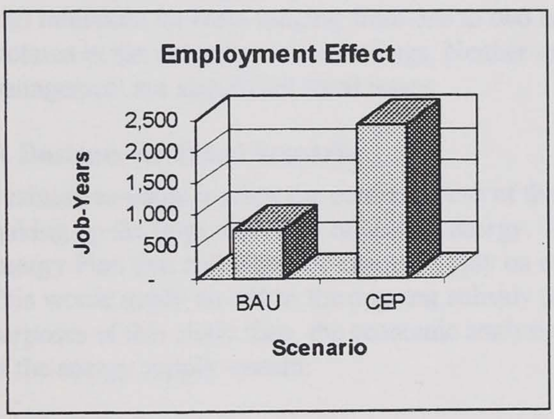


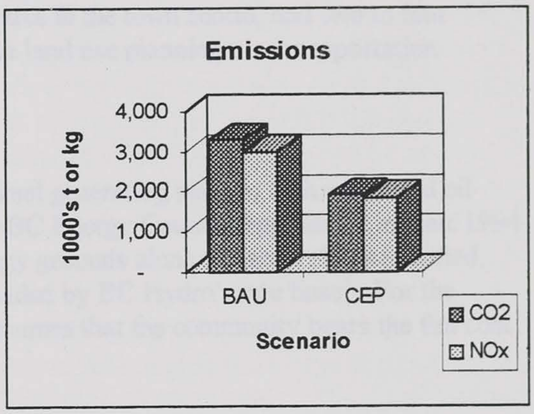


In the CEP scenario, roughly one third of all building energy is provided through local supply sources (heat pumps, micro-cogeneration, multi-fuel plant, sewage biogas, solar hot water, and solar photovoltaics). In BAU, all building energy is provided from the grid and natural gas mains.



Investments in local energy resources and in efficiency tend to create jobs locally. Investments in the energy system in 2010 create over twice as many local jobs in the community energy planning scenario relative to business-as-usual.





Community energy planning reduces carbon dioxide emissions and nitrous oxide emissions in 2010 by roughly 40%. For nitrous oxides, this assumes that the wood waste plant displaces a beehive burner. If it did not, nitrous oxides would rise slightly in the CEP scenario.

A2.4 Anahim Lake

Community Profile
Non integrated communities are communities that are not linked to a natural gas delivery system or to the electricity transmission grid. There are some forty of them in the province, ranging in population from 20-odd seasonal workers to permanent settlements of over 3000 people. Located in remote or inaccessible regions, the lack of a reliable and affordable energy supply is seen as a major obstacle to local economic development.

The cost of replacing or providing new energy supply is higher for non-integrated communities than anywhere else in the province. What this means is that non-conventional technologies that are not normally considered economically competitive elsewhere may constitute creative alternatives for the unique conditions of these communities. Most non integrated communities receive their energy services from a diesel generating station. It is an expensive system -- three to five times more costly than grid electricity.

Anahim Lake is a non-integrated community with a population of 1100, located in the Cariboo-Chilcotin Regional District, in the west central interior. There are roughly 350 dwellings in the community, most of which use oil as a primary fuel source for space and hot water heating, with wood as a back up fuel. A significant number of mobile homes use electricity for space and water heating. There are two schools, a small nursing clinic and a community learning centre.

Energy Profile
Currently BC Hydro has roughly 300 residential customers and 75 commercial customers in Anahim Lake. Power is supplied from BC Hydro Diesel Generating Sets which put out roughly 6000 megawatt hours annually, and meet a peak load of roughly 1500 kilowatts. Electricity sales are anticipated to grow at roughly 4% annually.

Urban Form
While relatively compact by small community standards, Anahim Lake is still very low density, with minimum lot sizes ranging from one to two hectares in the town centre, and two to four hectares in the immediate surroundings. Neither urban land use planning nor transportation management are significant local issues.

A Business-As-Usual Scenario
Business-as-usual implies the continued use of the diesel generating station, with wood and oil making up the largest portion of heating energy. The BC Energy Council emphasizes in their 1994 Energy Plan that subsidies for energy supply on energy grounds alone are generally unjustified. This would imply an end to the ongoing subsidy provided by BC Hydro's rate base[3] . For the purposes of this study then, the economic analysis assumes that the community bears the full cost of the energy supply system.

By 2010 in a business-as-usual scenario, energy consumption has grown to 10,000 megawatt hours per year with a peak of over 2500 kilowatts -- a 65% growth in peak since 1994. Equipment and fuel are purchased from external suppliers; money spent on energy goes straight out of the community without any local linkages or respending effect to boost the local economy. Further, the system is not an environmentally friendly one; it has significant emissions of sulfur and carbon dioxides, nitrous oxides and particulate.

A Future with Community Energy Planning
It is apparent that many of the strategies associated with urban land use planning and transportation management are of limited relevance in Anahim Lake and most other non-integrated communities[4] . Land use planning in Anahim Lake is done in the offices of the Cariboo Regional

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[3] BC Hydro's non integrated systems incur generation costs in the range of 15 to 25 c/kilowatt hour, while electricity is charged at 6c/kilowatt hour. Thus a subsidy is provided by the larger ratepayer base of roughly 10-20c/kilowatt hour.

[4] CORE initiated a local area plan in the region, however its primary focus is to address trade-offs among natural resources -- forestry, mining, protected areas etc.

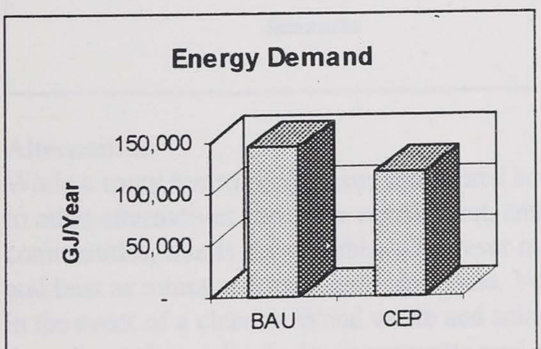
District planning department, five hours away. Transportation is not under the active jurisdiction of any central planning authority. While the general principles of defining a strict urban boundary and zoning for moderate densities and mixed uses remain desirable strategies for the long-term, transportation and land use planning measures were not modelled in this study. The effects of such measures are likely to be felt only over much extended time frame. The scenarios that follow therefore focus on the supply side options and demand-side management.

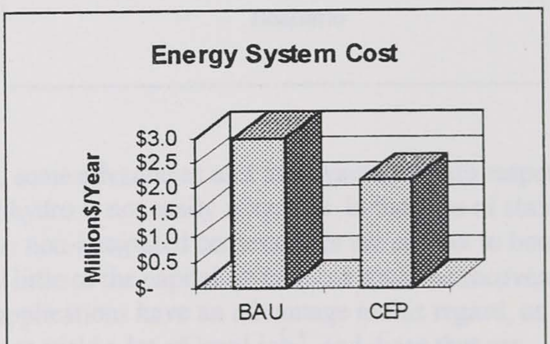
From 1994 to 2010, demand-side management initiatives contribute significantly to reducing the costs of supply alternatives by reducing the peak load. For capital intensive local supply options, this dramatically improves the economic picture. In partnership with the utility, financial incentives -- with an emphasis on providing access to capital -- are made available for improved insulation in electrically heated homes, high efficiency lighting and appliances, and solar hot water systems. By 2010, public education in peak reduction measures, investments in more efficient technologies, the use of passive solar and microclimate design principles in the construction of new homes, and the penetration of solar hot water heaters in one quarter of homes, have succeeded in reducing the peak load.

On the supply side, there are many technical options that deserve consideration. Studies have shown that there is potential for small hydro and wood waste generation. When the backstop price is the avoided cost of diesel generation, a multitude of options become viable, including solar or wind electricity systems. Without a site-specific study it is impossible to know which option would prove to be the most cost effective. However, under the assumption that a suitable site exists, which has been suggested by an independent project proponent at the latest BC Hydro rate hearings, small hydro has been selected for comparison. The costs have been calculated for a typical under-10 megawatt installation, plus the costs of lengthy transmission lines from the site.

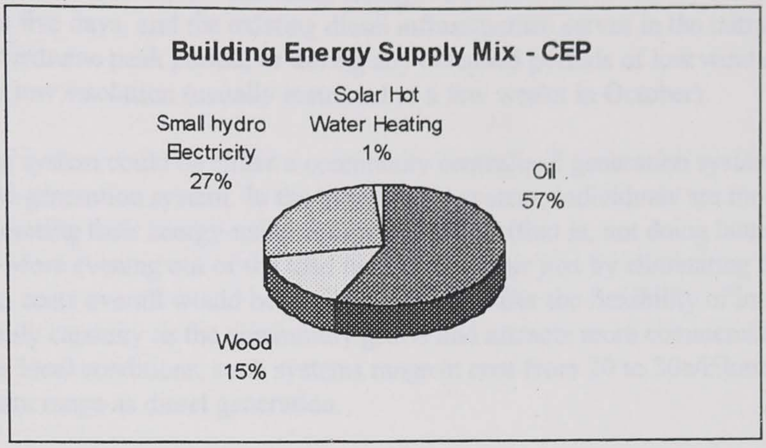
Results

As a result of an emphasis on improved efficiency, passive solar and microclimate design features, and increased financing mechanisms, total energy consumption drops roughly 17%. Peak load also drops relative to business-as-usual, remaining below 2000 kilowatts. Without subsidies of any kind applied, the total system cost of the small hydro system, calculated on a life-cycle cost basis, is 31% lower than the diesel generation system, for savings of over $700 per year per capita.

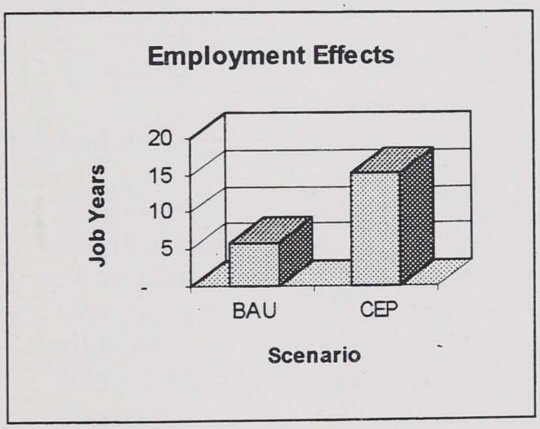


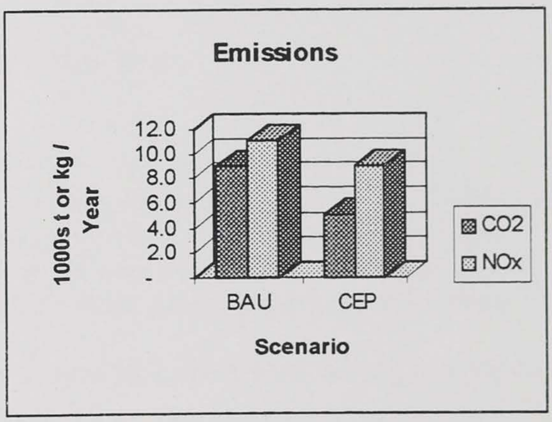


In the CEP scenario, 43% of building energy is provided through local sources (wood, small hydro, solar hot water), versus 15% (wood) in BAU.



In recognition that in very small communities, fewer goods and services are available locally, as well as fewer skilled workers, employment effects were scaled down. Nonetheless, based on the respending effect alone (resulting from reduced costs of energy services), 1.6 times more job years are realized in the CEP scenario. Dramatic reductions in emissions result from displacing diesel. Only carbon dioxide and nitrous oxides are shown, but similar reductions could be expected for sulfur dioxides and particulate matter as well.





Alternatives

While a small hydro project was considered here, some advantages and disadvantages with respect to other alternatives should be noted. First, small hydro is not easily relocated. In the case of stable communities, this is not a problem, however many non-integrated communities are subject to boom and bust as mines and mills open and close. Very little of the capital investment could be recovered in the event of a closure. Wood waste and solar applications have an advantage in this regard, as does diesel. Secondly, hydro investments tend not to yield a lot of local jobs, and those that are created are short term construction jobs. Wood waste on the other hand requires on-going labour, which matches well with skills available in the local community.

Many communities may not have access to resources such as small hydro or wood waste. For these communities, it is interesting to look briefly at other renewable alternatives. For example, a hybrid photovoltaic and wind powered system may provide primary power for all but 4-6 weeks of the year (personal communication, E. Auerbach, Energy Alternatives). A battery bank provides storage for up to five days, and the existing diesel infrastructure serves in the initial years as backup to cover extreme peak period, or during any extended periods of low wind speed accompanied by low insolation (usually restricted to a few weeks in October).

Interestingly, the system could be either a community centralized generation system, or a home-based distributed generation system. In the home-based system, individuals are more likely to be conscious of operating their energy-using equipment wisely (that is, not doing laundry at peak demand times). More evening out of the load is likely to occur just by eliminating the "commons" effect. However, costs overall would be similar, and both offer the flexibility of incremental additions to supply capacity as the community grows and attracts more commercial interests. Depending upon local conditions, such systems range in cost from 20 to 30c/kilowatt hour, the same approximate range as diesel generation.

APPENDIX A3
Modelling Assumptions and Output

A3.1 CITY OF PRINCE GEORGE

Land Use Planning

- Average trip length is reduced from 6.5 to 5.2 kilometers.
- The density of the downtown core is increased to nearly 50 people per hectare.
- 20% of total commercial space is in mixed use; 20% of heat used in that space is available to the residential sector as waste heat.
- Costs of infrastructure services are reduced by 30% per lot by locating new development contiguous to existing development, near to central facilities and employment centres, and by including multi-family housing types in equal proportion to single family conventional and single family cluster units.

Transportation Management

- Increase in the average commuter vehicle occupancy from 1.1 to 1.4 persons per vehicle.
- All municipal and fleet vehicles, and 10% of individual vehicles are converted to alternate fuel vehicles.
- The combination of transportation management and land use planning measures allows a modal shift to occur:

Transit	From less than 1% to 4%
Pedestrian/Cycling	From less than 2% to 5%
Auto HOV	From less than 5% to 12%
Auto SOV	From more than 92% to 79%

Site and Building Design

- Assume that the availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and existing buildings.
- All new buildings achieve savings of 10% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling and vegetative wind shielding.
- 25% of all homes use solar hot water heaters to meet 70% of hot water heating requirements per home.

Alternative Supply

- Roughly 12% of the city's energy load is expected to occur in the downtown core and be served by a district heating system.
- 20% of all new commercial buildings utilize distributed generation via natural gas engines with waste heat recovery.
- Heat pumps penetrate to only a limited degree due to the extreme climate (roughly 3%).
- The remainder is supplied by the natural gas and electric grid systems in proportions equal to those in 1994.

CITY OF PRINCE GEORGE

PRIMARY INDICATORS

		BAU	CEP
MUNICIPAL ACCOUNTS			
Operating Expenses	$/year	$ 7,194,050	$ 5,631,867
Annual Infrastructure Costs	$/year	$ 13,493,234	$ 8,586,604
Annual Net Revenue: Municipal Utility	$/year	$ -	$ (2,200,000)
SOCIO-ECONOMIC			
Percentage of Energy from Local Sources	%	0%	20%
Local Job Years from Energy Investment		117	337
ENVIRONMENTAL			
Total CO2 Emissions	t/year	444,974	307,502
Total NOx Emissions	t/year	324,427	218,140
ENERGY			
Total Energy Consumption	GJ/year	8,306,909	6,756,986
Total Annual Cost of Energy	$/year	$ 107,471,420	$ 91,646,942
Per Capita Annual Cost of Energy	$/cap/year	$ 1,176	$ 1,003

RESIDENTIAL SCENARIOS

	Units	BAU TOTAL	SFD	MFD	APT	CEP TOTAL	SFD	MFD	APT
Base Stock	No.	26,250	20,378	1,666	3,606	26,250	20,378	1,666	3,606
Base Energy Intensity Total	GJ/unit		115.0	75.0	40.0		115.0	75.0	40.0
Base Energy Intensity Heat	GJ/unit		93.2	60.8	32.4	-	93.2	60.8	32.4
Base Energy Intensity Non-heat	GJ/unit		21.9	14.3	7.6	-	21.9	14.3	7.6
Annual Increment	%	0.015				0.015			
No.of New Units by 2010		7,061				7,061			
Percent of each housing type			75%	15%	10%		50%	30%	20%
No.of new units each housing type			5,296	1,059	706		3,530	2,118	1,412
No each type total stock		32,711	25,674	2,725	4,312	32,711	23,908	3,784	5,018
Total Heat Demand	GJ	2,696,764	2,391,501	165,552	139,712	2,619,553	2,227,071	229,894	162,589
Total Non-Heat Demand	GJ	632,574	560,969	38,833	32,772	614,463	522,399	53,926	38,138
Total Building Energy Residential	GJ	3,329,338	2,952,470	204,385	172,483	3,234,017	2,749,470	283,820	200,727
DENSITY EFFECT									
Reduction in heat load	%	Caused by shift to multi-family dwellings				2.9%			
Reduction in total energy load	%					2.9%			
Total Energy Saved by density	GJ					95,322	2.9%	of total	
PASSIVE SOLAR EFFECT									
% Heating Reduction	%					10.0%			
Total Heat Energy Saved	GJ	Assume it affects all new homes				50,330	1.6%	of total	
Total non heat energy saved	GJ	Assume it affects all new homes				2,485			
% Savings on Lighting	%					20%			
MICROCLIMATE EFFECT									
% Heating Reduction	%	Assume it affects all new homes				5.0%			
Total htg energy saved by microclimate	GJ					25,165	0.8%	of total	
MIXED USE EFFECT									
Total Waste Heat Contribution	GJ	From Commercial				47,548			
% of total residential requirement	%					1.5%		of total	
SOLAR HOT WATER PREHEAT									
% Total Household Energy	%	Assume it meets 70% of hot water heating requirement				11.9%			
% all homes served	%	Assume it is implemented in new homes and retrofits e				25.0%			
Total heat energy savings	GJ					77,932	2.4%	of total	

COMMERCIAL SCENARIOS

	units		BAU	CEP
Base Stock	sq meters		1,390,000	1,390,000
Base Energy Intensity Total	GJ/sqm		1.05	1.05
Base Energy Intensity Heat (LOAD)	GJ/sqm		0.38	0.38
Base Energy Intensity Non-Heat	GJ/sqm		0.67	0.67
Annual Increment	%		0.015	0.025
Total new commercial space	sq meters		373,890	673,463
Total commercial space	sq meters		1,763,890	2,063,463
Total Head Load	GJ		677,423	792,475
Total Non-Heat Load	GJ		1,182,803	1,383,686
Total Building Energy Commercial	GJ		1,860,226	2,176,161
PASSIVE SOLAR				
% Heating Reduction per buildings	%	Assume affects all new buildings		10.0%
Total heating energy savings	GJ			25,864
% Savings on Light	%	Assume affects all new buildings		10%
Total Non Heat Energy Savings	GJ			43,977
MICROCLIMATE				
% Heating Reduction per building	%	Assume affects all new buildings		5.0%
Total heat energy savings	GJ			12,932
MIXED USE EFFECT				
% of stock in mixed use	%	40% of office/retail/restaurant		20%
% energy available to residential sector	%			30%
Total heat energy transferred to Residential	GJ			47,548
MICROCOGEN PENETRATION				
Percent served by microcogen	%	Of all commercial buildings		15.0%
Total non heat supplied	GJ	Assume sized to meet elec needs		67,740
Heat to power ratio				1.3
Total heat supplied	GJ			88,062
Total heat used (assume 50% is usable)	GJ	Assume 50% of available is useable		44,031

BUILDINGS: ENERGY SOURCES

TOTAL BUILDINGS LOAD

	BASE		BAU		CEP	
	%	GJ	%	GJ	%	GJ
Pre-DSM Load		4,211,025		5,189,565		5,505,499
DSM Efficiency	0%	-	10.0%	518,956	20.0%	1,101,100
DSM Density	0%	-	0.0%	-	1.7%	95,322
DSM Passive Solar	0%	-	0.0%	-	2.2%	122,657
DSM Microclimate	0%	-	0.0%	-	0.7%	38,097
DSM Mixed Use	0%	-	0.0%	-	0.9%	47,548
		-		-		
Net Energy Load		4,211,025		4,670,608		4,155,755
		-		-		-
Grid Electricity	37%	1,560,535	40.5%	1,892,239	37%	1,541,831
Natural Gas	63%	2,650,490	59.5%	2,778,369	43%	1,798,310
Wood Waste DHC	0%	-	0.0%	-	11%	468,739
Micro-cogeneration	0%	-	0.0%	-	3%	111,771
Solar Hot Water		-		-	2%	77,932
Heat Pumps	0%	-	0.0%	-	4%	156,471
NET LOAD	100%	4,211,025	100.0%	4,670,608	100%	4,155,053

Efficiency Assumptions

	BASE			BAU	CEP
Grid Electricity	100%			100%	100%
Natural Gas	70%			74%	78%
Wood Waste	70%	distn losses	15.0%		
Municipal Waste	70%	distn losses	15.0%		
Micro-cogeneration	85%				
Heat Pumps	250%				

TOTAL BUILDING ENERGY CONSUMPTION

	BASE		BAU		CEP	
	%	GJ	%	GJ	%	GJ
Grid Electricity	29%	1,560,535	34%	1,892,239	31.2%	1,541,831
Natural Gas	71%	3,786,415	66%	3,754,552	46.7%	2,305,525
Wood Waste	0%	-	0%	-	14.6%	721,698
Micro-cogeneration	0%	-	0%	-	2.7%	131,495
Heat Pump	0%	-	0%	-	3.2%	156,471
Solar Hot Water	0%	-	0%	-	1.6%	77,932
TOTAL		5,346,950		5,646,792		4,934,952
Local Supply		0.0%		0.0%		22%

TRANSPORTATION and LAND USE PLANNING

	Units	BASE	BAU	CEP
# Commuters		33,760	42,841	42,841
Average Distance (1-way)	km	5.8	6.5	5.2
Total Number of Trips		16,880,000	21,420,476	21,420,476
No. of trips per household/day		7	7	7
No. of households		26,250	32,711	32,711
Total no. of trips		67,068,750	83,576,274	83,576,274
Ave distance one way	km	5.8	6.5	5.2
Annual Casual Travel	VKT/yr	772,632,000	1,086,491,568	869,193,254
Annual Transit Trips	No.	592,000		
Total Transit Distance Travelled	Km/year	854,000	963,715	3,416,000
MODAL SPLIT				
Total number of trips		84,540,750	107,280,990	107,280,990
Ave Trip length		5.8	6.5	5.2
% SOV		92%	92%	79%
% HOV		5%	5%	12%
% Transit		1%	1%	4%
% Pedestrian/Bicycle		2%	2%	5%
Energy consumption rate SOV	GJ/km	0.0040	0.0040	0.0040
Transport energy consumed SOV	GJ/year	1,797,837	2,574,529	1,762,841
Energy Consumption rate HOV	GJ/km	0.0020	0.0020	0.0020
Energy Consumption HOV	GJ/year	48,695	69,733	133,887
Energy consumption rate BUS	GJ/km	0.0025	0.0025	0.0025
Actual Distance travelled BUS	KM	854,000	963,715	3,416,000
Transport energy consumed BUS	GJ/year	14,050	15,855	59,970
SUMMARY				
Total Transport energy	GJ/yr	1,860,583	2,660,117	1,956,698
Total Per Capita	GJ/cap/year	25.8	29.1	21.4
Gasoline Share Buses	%	100%	100%	0%
Gasoline Share Autos	%	100%	100%	90%
Alternate Fuel Share Bus	%	0%	0%	100%
Alternate Fuel Share Autos	%	0%	0%	10%
Gasoline Consumption	GJ/yr	1,860,583	2,660,117	1,707,055
Alternate Fuel Consumption	GJ/yr	0.00	0.00	249,643
VKT commute + casual	km/year	459,539,169	658,066,956	469,886,445
VKT/cap	km/cap/yr	6,382	7,202	5,143
				29%
TRANSIT COST BREAKDOWN				
Total Fuel Costs	$/year	$ 252,905	$ 285,396	$ 989,506
Total Labour Costs	$/year	$ 1,810,200	$ 2,297,118	$ 7,240,800
Total Other Costs	$/year	$ 522,895	$ 663,547	$ 2,091,581
Total Cost of Transit System	$/year	$ 2,586,000	3,246,060	10,321,887
Municipal Share of Cost	$/year	0.51	0.51	0.51
Total Revenue	$/year	$ 648,000	822,004	5,049,455
Net Municipal Cost	$/year	$ 670,860	833,486	214,707

MUNICIPAL FLEET				
No. of vehicles in municipal fleet		108	108	108
Annual Fleet Travel	VKT/year	3,240,000	3,656,250	2,925,000
Gasoline Share	%	100%	100%	0%
Gasoline Energy Consumption	GJ/year	12,960	14,625	-
Alternate Fuel Share	%	0%	0%	100%
Alternate Fuel Energy Consumption	GJ/year	0	0	11,700
Fuel Cost	$/year	$ 233,280	$ 277,875	$ 193,050

INFRASTRUCTURE

Km road		626	715	626
Cost of Road Maintenance	$/yr	990,000	$ 1,130,666	$ 990,000
Cost of Road Maintenance/km	$/km	1,581	1,581	1,581
No. Parking Spaces		9,800		
# parking spaces per 1000		136	-	-
Road/1000population	km/1000	9	8	7
Cost of snow removal/street cleaning	$/yr	$ 3,000,000	$ 3,426,261	$ 3,000,000
Cost of snow removal/km road	$/km/yr	$ 4,792	$ 4,792	$ 4,792
Average Cost of Services per Hhd	$/hhd	$ 25,000	$ 27,500	$ 17,500
Total cost of servicing lots	$/yr	$ 9,843,750	$ 13,493,234	$ 8,586,604
Waste water pumping cost	$/year	$ 92,000	$ 101,200	$ 91,080
Water supply pumping costs	$/year	$ 585,000	$ 643,500	$ 579,150
Pumping Cost per housing unit	$/hhd	$ 26		
Pumping Costs Total	$/year	$ 677,000	$ 952,012	$ 761,609
Total Infrastructure Costs	$/year	$ 14,510,750	$ 18,794,861	$ 13,246,834

MUNICIPAL ACCOUNTS

		BASE	BAU	CEP
Building Energy Costs	$/year	$ 675,000	$ 573,750	$ 472,500
Fleet Fuel Costs	$/year	$ 233,280	$ 277,875	$ 193,050
Transit Costs	$/year	$ 670,860	$ 833,486	$ 214,707
Road Maintenance	$/year	$ 990,000	$ 1,130,666	$ 990,000
Street Cleaning and Snow Removal	$/yr	$ 3,000,000	$ 3,426,261	$ 3,000,000
Pumping Energy Costs	$/year	$ 677,000	$ 952,012	$ 761,609
TOTAL MUNICIPAL COST	**$/year**	**$ 6,246,140**	**$ 7,194,050**	**$ 5,631,867**

OTHER FINANCIAL EFFECTS

		BASE	BAU	CEP
Lot Servicing Cost	$/year	$ 9,843,750	$ 13,493,234	$ 8,586,604
DHC Revenue	$/year	$ -	$ -	$ 2,200,000

COSTS AND EMPLOYMENT

BUILDING ENERGY						DIRECT, INDIRECT, INDUCED			Responding Effect			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	518,956	1,404,724		$ 5,632,866	$ 11,921,671	13.6	77	162						38	81
Electricity Grid	1,892,239	1,541,831	$ 17.80	$ 33,681,861	$ 27,444,600	3.3	111	91							
Natural Gas Mains	3,754,552	2,305,525	$ 5.40	$ 20,274,583	$ 12,449,835	3.3	67	41							
Total Local Supply	-	1,009,664		$ -	$ 5,509,363	3.3	-	18						-	9
TOTAL	**6,165,748**	**6,261,745**		**$ 59,589,310**	**$ 57,325,470**		**255**	**312**	**$ 2,263,840**	**12**	**27**	**255**	**339**	**38**	**117**

TRANSPORTATION ENERGY						DIRECT, INDIRECT, INDUCED			Responding Effect			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
Gasoline	2,660,117	1,707,055	$ 18.00	$ 47,882,109	$ 30,726,992	3.30000	158	101						79	51
Alternate Fuels	-	249,643	$ 16.50	$ -	$ 4,119,107	3.30000	-	14						-	7
TOTAL	**2,660,117**	**1,956,698**		**47,882,109**	**34,846,099**		**158**	**115**	**13,036,010**	**12.0**	**156**	**158**	**271**	**79**	**214**

EMISSIONS

	BUILDING ENERGY					TOTAL CO2			TOTAL NOx		
	BASE	BAU	CEP	CO2	NOx	BASE	BAU	CEP	BASE	BAU	CEP
Energy Source	GJ	GJ	GJ	t/GJ	kg/GJ	t	t	t	kg	kg	kg
DSM Total	-	518,956	1,404,724	-	-	-	-	-	-	-	-
Electricity Grid	1,560,535	1,892,239	1,541,831	0.0381	0.0108	59,514	72,164	58,801	16,854	20,436	16,652
Natural Gas Mains	2,650,490	3,754,552	2,305,525	0.0497	0.0421	131,729	186,601	114,585	111,692	158,217	97,155
Wood Waste DHC	-	-	721,698	-	-	-	-	-	-	-	-
Micro-cogeneration	-	-	131,495	0.0252	0.0263	-	-	3,307	-	-	3,463
Heat Pumps	-	-	156,471	0.0153	0.0043	-	-	2,387	-	-	676
TOTAL	**4,211,025**	**5,646,792**	**4,857,021**			**191,243**	**258,766**	**179,079**	**128,545**	**178,653**	**117,946**

	TRANSPORT ENERGY					TOTAL CO2			TOTAL NOx		
	BASE	BAU	CEP	CO2	NOx	BASE	BAU	CEP	BASE	BAU	CEP
Energy Source	GJ	GJ	GJ	t/GJ	kg/GJ	t	t	t	kg	kg	kg
Gasoline	1,860,583	2,660,117	1,707,055	0.0700	0.0548	130,241	186,208	119,494	101,960	145,774	93,547
Alternate Fuel	-	-	249,643	0.0365	0.0274	-	-	9,112	-	-	6,840
TOTAL	**1,860,583**	**2,660,117**	**1,956,698**			**130,241**	**186,208**	**128,606**	**101,960**	**145,774**	**100,387**

A3.2 CITY OF CASTLEGAR

Land Use Planning

- Decrease in the average trip length from 4.1 to 3.3 kilometers.
- 30% of residential growth occurs in the downtown and neighboring areas. Overall, residential growth is accommodated in equal proportions of single family dwellings to multi-family and apartment.
- 40% of all office and retail space is in mixed use, representing roughly 15% of commercial space; 30% of heat in this space is available to the residential sector as waste heat.
- Costs of infrastructure services are reduced by 30% per lot through locating development near to central facilities, contiguous with existing development, and by including multi-family housing types in equal proportion to single family conventional and single family cluster units.

Transportation Management

- Increase in the average commuter vehicle occupancy from 1.1 to 1.3 persons per vehicle.
- All municipal and fleet vehicles, and 10% of individual vehicles are converted to alternate fuel vehicles
- The combination of transportation management and land use planing strategies allows a modal shift to occur:

Transit:	From less than 1% to 3%
Pedestrian/cycling	From less than 4% to 10%
Auto HOV	From less than 5% to 10%
Auto SOV	From more than 90% to 77%

Site and Building Design

- Availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and exiting buildings.
- All new buildings achieve savings of 15% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling, and vegetative wind shielding.
- 50% of all homes use solar hot water heaters to meet 85% of hot water heating requirements per home.

Alternative Supply

- By 2010, the district energy system meets 28% of the city's building energy needs.
- 20% of all new commercial buildings utilize distributed generation via natural gas engines with waste heat recovery.
- Heat pumps overall meet 10% of the city's building energy needs.
- The remainder is supplied by the natural gas and electric grid systems in proportions equal to those in 1994.

CITY OF CASTLEGAR

PRIMARY INDICATORS

MUNICIPAL ACCOUNTS					
Operating Expenses	$/year	$	1,604,896	$	1,227,611
Annual Infrastructure Costs	$/year	$	3,693,633	$	2,350,494
Annual Net Revenue:Municipal Utility	$/year	$	-	$	1,000,000
SOCIO-ECONOMIC					
Percentage of Energy from Local Sources	%		0%		37%
Local Employment from Energy Investments	job-years		14		51
ENVIRONMENTAL					
Total CO2 Emissions	t/year		55,519		31,598
Total NOx Emissions	t/year		38,346		20,482
ENERGY					
Total Energy Consumption	GJ/year		1,096,993		844,143
Total Annual Cost of Energy	$/year	$	14,372,123	$	11,763,077
Per Capita Annual Cost of Energy	$/cap/year	$	1,249	$	1,022

TRANSPORTATION

	Units	BASE	BAU	CEP
# Commuters		2,785	4,469	4,469
Average Distance (1-way)	km	3.9	4.1	3.3
Total number of trips	trips/yr	1,392,500	2,234,554	2,234,554
No. of trips per household/day		7	7	7
No. of households		2,790	4,477	4,477
Total no. of trips		7,128,450	11,439,070	11,439,070
Ave distance one way	km	3.9	4.1	3.3
Annual Casual Travel	VKT/yr	55,601,910	93,800,371	75,497,859
Annual Transit Trips	No.	23,000		
Total Transit Distance Travelled	Km/year	50,000	52,564	200,000
MODAL SPLIT				
Total number of trips		8,543,950	13,710,532	13,710,532
Ave Trip length		4.7	4.9	3.9
% SOV		90%	90%	77%
% HOV		5%	5%	10%
% Transit		1%	1%	3%
% Pedestrian/Bicycle		4%	4%	10%
Energy consumption rate SOV	GJ/km	0.0040	0.0040	0.0040
Transport energy consumed SOV	GJ/year	143,390	241,899	166,576
Energy Consumption rate HOV	GJ/km	0.0020	0.0020	0.0020
Energy Consumption HOV	GJ/year	3,983	6,719	10,817
Energy consumption rate BUS	GJ/km	0.0025	0.0025	0.0025
Actual Distance travelled BUS	km	50,000	80,235	200,000
Transport energy consumed BUS	GJ/year	823	1,320	3,290
SUMMARY				
Total Transport energy	GJ/yr	154,241	249,938	180,683
Total Per Capita	GJ/cap/yr	21.5	21.7	15.7
Gasoline Share Buses	%	100%	100%	0%
Gasoline Share Autos	%	100%	100%	90%
Alternate Fuel Share Bus	%	0%	0%	100%
Alternate Fuel Share Auto	%	0%	0%	10%
Gasoline Consumption	GJ/yr	148,196	249,938	159,653
Alternate Fuel Consumption	GJ/yr	0.00	0.00	21,030
VKT commute + casual	km/year	36,671,960	61,865,574	43,980,320
VKT/cap	kn/cap/yr	5,115	5,377	3,822
TRANSIT COST BREAKDOWN				
Total Fuel Costs	$/year	$ 14,807	$ 23,761	$ 54,293
Total Labour Costs	$/year	$ 141,400	$ 226,905	$ 565,600
Total Other Costs	$/year	$ 45,793	$ 73,484	$ 183,172
Total Cost of Transit System	$/year	$ 202,000	324,151	803,064
Municipal Share of Cost	$/year	0.51	0.51	0.51
Total Revenue	$/year	$ 19,900	83,038	379,603
Net Municipal Cost	$/year	$ 83,120	82,279	29,960

MUNICIPAL FLEET				
No. of vehicles in municipal fleet		43	43	43
Annual Fleet Travel	VKT/year	946,000	994,513	946,000
Gasoline Share	%	100%	100%	0%
Gasoline Consumption	GJ/year	3,784	3,978	-
Alternate Fuel Share	%	0%	0%	100%
Alternate Fuel Energy Consumption	GJ/year	-	-	3,784
Fuel Cost	$/year	$ 68,112	$ 75,583	$ 62,436

INFRASTRUCTURE

Km road		79	101	79
Cost of Road Maintenance	$/yr	640,000	$ 821,610	$ 640,000
Cost of Road Maintenance/km	$/km	8,101	8,101	8,101
No. Parking Spaces		1,800		
Street cleaning and snow removal	$/year	300,000	385,130	300,000
Cost / km road	$/km	3,797		
Average Costs of Services per Hhd	$/hhd	$ 25,000	$ 27,500	$ 17,500
Total cost of servicing lots	$/yr	$ 2,092,500	$ 3,693,633	$ 2,350,494
Pumping Cost per housing unit	$/hhd	$ 30		
Total Pumping Costs	$/year	$ 85,000	$ 143,395	$ 115,415
Total Infrastructure Costs	$/year	$ 2,817,500	$ 4,658,638	$ 3,105,909

MUNICIPAL ACCOUNTS

		BASE	BAU	CEP
Building and Street Light Energy Costs	$/year	$ 114,000	$ 96,900	$ 79,800
Fleet Transport Costs	$/year	$ 68,112	$ 75,583	$ 62,436
Transit Costs	$/year	$ 83,120	$ 82,279	$ 29,960
Road Maintenance	$/year	$ 640,000	$ 821,610	$ 640,000
Street cleaning and snow removal	$/yr	$ 300,000	$ 385,130	$ 300,000
Pumping Energy Costs	$/year	$ 85,000	$ 143,395	$ 115,415
TOTAL MUNICIPAL COST	**$/year**	**$ 1,290,232**	**$ 1,604,896**	**$ 1,227,611**

OTHER FINANCIAL EFFECTS

		BASE	BAU	CEP
Lot Servicing Cost	$/year	$ 2,092,500	$ 3,693,633	$ 2,350,494
DHC Revenue	$/year	$ -	$ -	$ 1,000,000

COSTS AND EMPLOYMENT

BUILDING ENERGY						DIRECT, INDIRECT, INDUCED			RESPENDING EFFECT			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	79,828	222,736		$ 928,990	$ 1,714,262	13.6	13	23						6	12
Electricity Grid	352,431	233,583	$ 17.80	$ 6,273,277	$ 4,157,779	3.3	21	14							
Natural Gas Mains	494,624	184,308	$ 5.40	$ 2,670,970	$ 995,265	3.3	9	3							
Local Supply Total	-	245,568		$ -	$ 1,675,025	3.3	-	6						-	3
TOTAL	926,883	886,196		$ 9,873,237	$ 8,642,331		42	46	$ 1,330,906	12	16	42	62	6	30

TRANSPORTATION ENERGY						DIRECT, INDIRECT, INDUCED			RESPENDING EFFECT			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
Gasoline	249,938	159,653	$ 18.00	$ 4,498,886	$ 2,873,756	3.30	15	9						7	5
Alternate Fuel	-	21,030	$ 16.50	$ -	$ 346,990	3.30	-	1						-	1
TOTAL	249,938	180,683		4,498,886	3,220,746		15	11	1,278,140	12.0	15	15	26	7	21

EMISSIONS

	BUILDING ENERGY					TOTAL CO2			TOTAL NOx		
Energy Source	BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	BASE t	BAU t	CEP t	BASE kg	BAU kg	CEP kg
DSM Total	-	79,828	222,736	-	-	-	-	-	-	-	-
Electricity Grid	188,238	352,431	233,583	0.0381	0.0108	7,179	13,441	8,908	2,033	3,806	2,523
Natural Gas Mains	249,576	494,624	184,308	0.0497	0.0421	12,404	24,583	9,160	10,517	20,843	7,767
DHC - wood	-	-	129,676	-	-	-	-	-	-	-	-
Solar Hot Water	-	-	26,044			-	-	-	-	-	-
DHC - gas						-	-	-	-	-	-
Microcogen comm	-	-	21,776	0.0252	0.0263	-	-	548	-	-	573
Microcogen res						-	-	-	-	-	-
Cogen sewage						-	-	-	-	-	-
Heat Pumps	-	-	68,073	0.0153	0.0043	-	-	1,038	-	-	294
TOTAL	437,815	847,055	663,460			19,583	38,023	19,654	12,650	24,650	11,157

	TRANSPORT ENERGY					TOTAL CO2			TOTAL NOx		
Energy Source	BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	BASE t	BAU t	CEP t	BASE kg	BAU kg	CEP kg
Gasoline	148,196	249,938	159,653	0.0700	0.0548	10,374	17,496	11,176	8,121	13,697	8,749
Alternate Fuel	-	-	21,030	0.0365	0.0274	-	-	768	-	-	576
TOTAL	148,196	249,938	180,683			10,374	17,496	11,943	8,121	13,697	9,325

A3.3 CITY OF SURREY

Land Use Planning

- 30% of residential growth occurs in or within walking distance of the mixed use nodes. Overall, residential growth is accommodated in equal proportions of singe family dwellings to multi-family and apartments.
- Average casual and intra-city commute trip length decreases from 5.7 to 4.2 kilometers.
- 40% of all office and retail space is in mixed use; 30% of the heat used in that space is available to the residential sector as waste heat.
- Costs of infrastructure services are reduced by 30% per lot through locating development near to central facilities and employment centres, contiguous with existing development, and by including multi-family conventional and single family cluster units.

Transportation Management

- Increase in the average commuter vehicle occupancy from 1.28 to 1.4 persons per vehicle.
- All municipal and fleet vehicles and 10% of individual vehicles are converted to alternative fuel vehicles.
- The combination of transportation management and land use planning strategies allows a modal shift to occur:

Transit	From less than 5% to 10%
Pedestrian/cycling	From less than 10% to 15%
Auto HOV	From less than 13% to 20%
Auto SOV	From more than 70% to 50%

Site and Building Design

- Assume that the availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and existing buildings.
- All new buildings achieve savings of 15% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling and vegetative wind shielding.
- 50% of homes use solar hot water heaters to meet 85% of hot water heating requirements per home

Alternative Supply

- By 2010, a multi-fueled district energy system meets roughly 6% of the city's building energy needs.
- A cogeneration plan on the sewage treatment facilities provides a further 3%
- A solar photovoltaic roof-top plant meets a further 3% of energy requirements in the form of electricity.
- of all new commercial buildings utilize distributed generation via natural gas engines with waste hat recovery.
- Heat pumps, when installed, meet all the heating and cooling needs of the building with a payback of 3 to 5 years. Overall, heat pumps meet 12% of building heating requirements.
- The remainder of building energy is supplied by the natural gas and electric grid systems in proportions equal to those in 1994.

CITY OF SURREY

PRIMARY INDICATORS

			BAU		CEP
MUNICIPAL ACCOUNTS					
Selected Operating Expenses	$/year	$	29,942,268	$	17,141,368
Annual Infrastructure Costs	$/year	$	146,129,389	$	102,290,572
Annual Net Revenue:Municipal Utility	$/year	$	-	$	2,267,000
SOCIO-ECONOMIC					
Percentage of Energy from Local Sources	%		0%		33%
Local Jobs from Energy Investments	Job-Years		753		2449
ENVIRONMENTAL					
Total CO2 Emissions	t/year		3,280,184		1,897,537
Total NOx Emissions	kg/year		2,956,466		1,805,475
ENERGY					
Total Energy Consumption	GJ/year		48,645,073		34,382,037
Total Annual Cost of Energy	$/year	$	636,802,244	$	498,177,167
Per Capita Annual Cost of Energy	$/cap/year	$	1,145	$	896

TRANSPORTATION

	Units	BASE	BAU	CEP
# Commuters		114,725	232,016	232,016
Average Distance (1-way)	km	18.7	18.7	18.7
Total Number of Trips		57,362,500	116,008,208	116,008,208
No. of trips per household/day		8	8	8
No. of households		80,285	162,366	162,366
Total no. of trips		234,432,200	474,108,684	474,108,684
Ave distance one way	km	4.9	5.7	4.2
Annual Casual Travel	VKT/yr	2,316,190,136	5,404,839,000	3,982,512,947
Annual Transit Trips	No.	6,960,000		
Total Transit Distance Travelled	Km/year	9,862,000		
MODAL SPLIT				
Total number of trips		298,754,700	604,192,588	604,192,588
Ave Trip length	km	9.5	10.3	8.8
% SOV		70%	72%	50%
% HOV		13%	13%	20%
% Transit		7%	5%	15%
% Pedestrian/Bicycle		10%	10%	15%
Energy consumption rate SOV	GJ/km	0.0040	0.0040	0.0040
Transport energy consumed SOV	GJ/year	7,959,962	17,880,390	10,604,360
Energy Consumption rate HOV	GJ/km	0.0020	0.0020	0.0020
Energy Consumption HOV	GJ/year	739,139	1,614,202	2,120,872
Energy consumption rate BUS	GJ/km	0.0025	0.0025	0.0025
Actual Distance travelled BUS	KM	8,540,000	9,853,846	34,160,000
Transport energy consumed BUS	GJ/year	497,498	776,059	1,988,318
SUMMARY				
Total Transport energy	GJ/yr	9,202,644	20,270,651	14,713,550
Total Per Capita	GJ/cap/yr	33.5	36.4	26.5
Gasoline Share Buses	%	100%	100%	0%
Gasoline Share Autos	%	100%	100%	90%
Alternate Fuel Share Bus	%	0%	0%	100%
Alternate Fuel Share Auto	%	0%	0%	10%
Gasoline Consumption	GJ/yr	9,196,599	20,270,651	11,452,709
Alternate Fuel Consumption	GJ/yr	0.00	0.00	3,260,841
VKT commute + casual	km/year	2,157,718,390	4,823,980,326	3,154,797,124
VKT/capita	km/cap/year	7,846	8,674	5,673
% Reduction in per capita VKT	%			35%

MUNICIPAL FLEET				
No. of vehicles in municipal fleet		180	180	180
Annual Fleet Travel	VKT/year	3,960,000	4,569,231	3,960,000
Gasoline Share	%	75%	75%	0%
Gasoline Consumption	GJ/year	11,880	13,708	0.00
Alternate Fuel Share	%	25%	25%	100%
Alternate Fuel Consumption	GJ/year	3960.00	4569.23	15,840
Fuel Cost	$/year	$ 279,180	$ 335,838	$ 261,360

INFRASTRUCTURE

Km road		1,400	2123	1699
Road per 1000 Population		5	3.82	3.05
Cost of Road Maintenance	$/yr	3,400,000	$ 5,157,044	$ 4,125,635
Cost of Road Maintenance/km	$/km	2,429	$ 2,429	$ 2,429
Average Cost of Services per Hhd	$/year	$ 20,000	$ 20,000	$ 14,000
Total cost of servicing lots	$/yr	$ 72,256,500	$ 146,129,389	$ 102,290,572
Water and Wastewater Pumping	$/year	$ 674,000	$ 777,692	$ 573,036
Pumping Cost per housing unit	$/hhd	$ 8	$ 8	$ 6
Pumping Costs Total	$/year	$ 674,000	$ 1,499,385	$ 1,004,373
Total Infrastructure Costs	$/year	$ 76,330,500	$ 152,064,125	$ 106,989,244

MUNICIPAL ACCOUNTS

		BASE	BAU	CEP
Building Energy Costs	$/year	$ 1,000,000	$ 850,000	$ 700,000
Fleet Fuel Costs	$/year	$ 279,180	$ 335,838	$ 261,360
Road Maintenance	$/year	$ 3,400,000	$ 5,157,044	$ 4,125,635
Pumping Energy Costs	$/year	$ 674,000	$ 1,499,385	$ 1,004,373
MUNICIPAL EXPENSES	**$/year**	**$ 5,353,180**	**$ 7,842,268**	**$ 6,091,368**

OTHER FINANCIAL EFFECTS

		BASE	BAU	CEP
Lot Servicing Cost	$/year	$ 72,256,500	$ 146,129,389	$ 102,290,572
DHC Revenue	$/year	$ -	$ -	$ 2,267,000

COSTS AND EMPLOYMENT

BUILDING ENERGY						DIRECT, INDIRECT, INDUCED			Respending Effect			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	2,571,182	8,693,658		$ 22,845,898	$ 34,918,831	13.6	311	475						155	237
Electricity Grid	7,865,999	4,814,221	$ 17.80	$ 140,014,782	$ 85,693,127	3.3	462	283							
Natural Gas Mains	20,641,410	8,364,723	$ 5.40	$ 111,463,613	$ 45,169,506	3.3	368	149							
Total Local Supply	-	6,586,073		$ -	$ 74,148,507	3.3	-	245						-	122
TOTAL	**31,078,591**	**28,458,675**		**$ 274,324,293**	**$ 239,929,971**		**1,141**	**1,151**	**$ 34,394,321**	**12**	**413**	**1,141**	**1,564**	**155**	**773**

TRANSPORTATION ENERGY						DIRECT, INDIRECT, INDUCED			Respending Effect			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
Gasoline	20,270,651	11,452,709	$ 18.00	$ 364,871,717	$ 206,148,760	3.30000	1,204	680						602	340
Alternate Fuel	-	3,260,841	$ 16.50	$ -	$ 53,803,872	3.30000	-	178						-	89
TOTAL	**20,270,651**	**14,713,550**		**364,871,717**	**259,952,632**		**1,204**	**858**	**104,919,085**	**12.0**	**1,259**	**1,204**	**2,117**	**602**	**1,688**

EMISSIONS

	BUILDING ENERGY					TOTAL CO2			TOTAL NOx		
	BASE	BAU	CEP	CO2	NOx	BASE	BAU	CEP	BASE	BAU	CEP
Energy Source	GJ	GJ	GJ	t/GJ	kg/GJ	t	t	t	kg	kg	kg
DSM Total	-	2,571,182	8,693,658	-	-	-	-	-	-	-	-
Electricity Grid	3,472,125	7,865,999	4,814,221	0.0381	0.0108	132,416	299,986	183,600	37,499	84,953	51,994
Natural Gas Mains	10,847,355	20,641,410	8,364,723	0.0497	0.0421	539,114	1,025,878	415,727	457,108	869,829	352,489
Multi-fuel DHC	-	-	1,106,147	0.0149	0.0680	-	-	16,482	-	-	75,218
Solar Hot Water			1,075,542	-	-	-	-	-	-	-	-
Solar PV			549,473	-	-	-	-	-	-	-	-
Micro-cogeneration	-	-	887,075	0.0252	0.0263	-	-	22,310	-	-	23,362
Cogeneration (Sewage)				0.0252	0.0263	-	-	-	-	-	-
Heat Pumps	-	-	2,425,986	0.0153	0.0043	-	-	37,008	-	-	10,480
TOTAL	**14,319,480**	**28,507,409**	**19,223,168**			**671,530**	**1,325,864**	**675,126**	**494,606**	**954,782**	**513,543**

	TRANSPORT ENERGY					TOTAL CO2			TOTAL NOx		
	BASE	BAU	CEP	CO2	NOx	BASE	BAU	CEP	BASE	BAU	CEP
Energy Source	GJ	GJ	GJ	t/GJ	kg/GJ	t	t	t	kg	kg	kg
Gasoline	9,196,599	20,270,651	11,452,709	0.0970	0.0994	892,512	1,967,226	1,111,462	914,142	2,014,903	1,138,399
Alternate Fuel	-	-	3,260,841	0.0365	0.0497	-	-	119,021	-	-	162,064
TOTAL	**9,196,599**	**20,270,651**	**14,713,550**			**892,512**	**1,967,226**	**1,230,483**	**914,142**	**2,014,903**	**1,300,463**

A3.4 ANAHIM LAKE

Land Use Planning

- 20% of new commercial development is in mixed use; 30% of the heat used in that development is available to the residential sector as waste heat.

Site and Building Design

- Assume that the availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and existing buildings.
- All new buildings achieve savings of 10% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling, and vegetative wind shielding.
- 50% of all homes use solar hot water heaters to meet 70% of hot water heating requirements per home.

Alternative Supply

- The micro-hydro station displaces the diesel generating station. Public education campaigns and financing and technical assistance programs succeed in holding peak load below 2000 kW and total consumption below 10,000 megawatt hours.
- 20% of all new commercial buildings utilize distributed generation via propane fueled engines with waste heat recovery. These meet their own needs for heating and exceed them for electricity.

ANAHIM LAKE

PRIMARY INDICATORS

		BAU	CEP
SOCIO-ECONOMIC			
Percentage of Energy from Local Sources	%	15%	45%
Local Jobs from Energy Investments		6	16
Per Capita Annual Cost of Energy	$/cap/year	$ 2,407	$ 1,624
Total Annual Cost of Energy	$/year	$ 3,104,705	$ 2,095,087
ENVIRONMENTAL			
Total CO2 Emissions	t/year	8,945	4,864
Total NOx Emissions	kg/year	11,087	9,010
ENERGY			
Total Energy Consumption	GJ/year	145,320	120,573

COSTS AND EMPLOYMENT

BUILDINGS

Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	DIRECT, INDIRECT, INDUCED: Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Respending Effect: Savings	Respend Multiplier	# Job-Yrs Respend	TOTAL: Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	**13,049**	**29,054**		**$ 335,362**	**$ 670,724**	**13.6**	**5**	**9**						**2**	**4**
Diesel Electricity	**36,810**	**-**	**$ 47.87**	**$ 1,762,201**	**$ -**	**3.3**	**6**	**-**						**2**	**-**
Oil	**86,615**	**66,535**	**$ 9.10**	**$ 788,194**	**$ 605,468**	**3.3**	**3**	**2**						**1**	**-**
Wood	21,895	18,544	$ 10.00	$ 218,948	$ 185,436									-	-
Small Hydro	-	32,282	$ 18.31	$ -	$ 590,989									-	-
Solar Hot Water	-	3,212	$ 13.22	$ -	$ 42,469									-	-
Total Local Supply	**21,895**	**54,038**		**$ 218,948**	**$ 818,895**	**3.3**	**1**	**3**						**1**	**2**
TOTAL	**158,369**	**149,627**		**$ 3,104,705**	**$ 2,095,087**		**14**	**14**	**$ 1,009,618**	**12**	**10**	**14**	**24**	**6**	**16**

EMISSIONS

Energy Source	BUILDING ENERGY: BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	TOTAL CO2: BASE t	BAU t	CEP t	TOTAL NOx: BASE kg	BAU kg	CEP kg
DSM Total	-	13,147	29,250	-	-	-	-	-	-	-	-
Diesel Electricity	21,163	36,810	-	0.0710	0.0100	1,503	2,614	-	212	368	-
Oil	41,422	86,615	66,535	0.0731	0.0100	3,028	6,332	4,864	414	866	665
Wood	10,472	21,895	18,544	-	0.4500	-	-	-	4,712	9,853	8,345
Small Hydro	-	-	32,282	-	-	-	-	-	-	-	-
Solar Hot Water	-	-	-	-	-	-	-	-	-	-	-
						-	-	-	-	-	-
TOTAL	**73,057**	**145,320**	**117,361**			**4,531**	**8,945**	**4,864**	**5,338**	**11,087**	**9,010**

APPENDIX A4
Community Energy Planning Guide

Figure A1 illustrates the six major steps involved in community energy planning. Depending on the resources available, each step can be executed at various levels of complexity. The following outlines the basic objectives of each step and provides some guidelines to assist a community in conducting the most basic analysis. Although the details that follow outline only the technical requirements of a community energy plan, public involvement at all stages of the process will be key to its success.

Step 1 Identify Planning Objectives

Identify long-term community objectives (e.g., air quality, affordability, etc.) along with performance indicators. Suitable indicators are measurable, define the baseline conditions of the community, and can be tracked over time to indicate progress toward long-term objectives. Examples include net residential density, per capita vehicle kilometers travelled, air quality indices, annual expenditures on municipal and energy services, etc.. More discussion on indicators / performance targets is included in Appendix B5.

Step 2 Collect and Analyze Data

There are two types of data to collect.

Community Benchmark Data
These data establish the baseline conditions of the community and are used to set realistic performance targets for the future. The types of data required will be determined by the planning objectives and indicators established in Step 1. Examples of useful data include: population and employment growth trends by district; housing unit numbers and types by district; office, retail and service floor space by district; costs of linear infrastructure, etc..

Energy Data
Conducting an energy analysis requires an inventory of energy sources (e.g., the percentage of building energy supplied by each source); total energy use in buildings; energy use in buildings by fuel type (e.g., electricity, natural gas, other) and by sector (e.g., residential, commercial, industrial); total cost of energy use in buildings (normally available from energy utilities and/or other fuel suppliers); energy end-use consumption patterns (e.g., percentage of building energy used for end-uses such as lights, heating, ventilation, etc.); transportation energy use (e.g., total vehicle fuel consumption by fuel type; transportation modal shares (e.g., percentage of total kilometers travelled by bus, auto, etc.); total transportation energy cost; and transportation energy cost by mode.

Given the realities of limited resources, extensive data collection may not be possible. As a minimum, energy data collected should include the total quantity of energy used in the community by fuel type, the total cost of this energy, and the percentage of energy used in transportation versus buildings.

Step 3 Develop Scenarios

Establish two scenarios: a "Base case" and a "CEP Case". Base case is a composite of existing plans under consideration intended to reflect a continuation of current trends. CEP Case involves the addition of selected CEP measures and strategies designed to improve the efficiency of proposed developments. A comparison of the two plans over a fifteen to twenty year time frame provides an estimate of the savings associated with the CEP Case.

Scenario development and analysis can be done at various levels of detail. Computer assisted planning and analytical tools are available to provide detailed quantitative analysis. However, communities can do a relatively simple analysis to develop a rough estimate of the order-of-magnitude of savings expected. The following are guidelines for a preliminary analysis:

Building Energy Savings

- Forecast the number and types of housing in the Base Case and the CEP Case. The energy consumed per unit varies by housing type. This information is available from energy utilities serving your area. There will be energy savings associated with a shift to multi-unit housing types.
- Assume that increased information, financing and technical assistance will help consumers and businesses save an additional 15% on their energy consumption in the CEP Case.

Transportation Energy Savings

- Create a Base Case by identifying the most likely areas for new subdivisions and the expected number of residents in each. Divide the community as envisioned in twenty years into four to eight districts. Make a rough estimation of the number of people living in each district and the distance from the centre of the district to the nearest mixed use centre offering a diversity of services such as grocery, other retail, restaurants, personal and professional services, etc.. Calculate the weighted average distance travelled by multiplying number of people by the distance for each district and summing over all districts.
- Create a CEP Case which assumes new patterns of land use leading to a more compact and mixed use community over a twenty year period. Specifically, try to accommodate 30% of new population growth within an existing mixed use node, and the additional 70% in contiguous development (i.e., avoiding development separated by vacant land). Again, divide the community into distinct districts and calculate the weighted average distance travelled.

Local Supply

- Identify the sources of energy used today for building energy and their total cost. For a Base Case, assume energy continues to be used by each source in the same proportions and at the same real cost over the evaluation time frame.
- Identify potential local sources of energy and their unit costs. Local sources are those that require investments - both capital and operating/maintenance - to businesses located in the community or surrounding region.
- Identify the environmental characteristics of each local source including: unit emissions of carbon dioxide, nitrous oxides, and particulate; use of renewable fuel sources; land and water use compatibility; etc.. These must be compared against the characteristics of current sources during the evaluation phase.
- Estimate the percentage of building energy that could be supplied by these local sources in a CEP scenario.

Step 4 Evaluate Scenarios

The process for evaluating different scenarios depends on the objectives identified in Step 1. As communities will have multiple objectives, it will be necessary to evaluate each scenario with respect to each objective, using the indicators identified in Step 1. Then stakeholders and decision makers must make trade-offs among objectives, or generate alternative scenarios that minimize the need to trade-off. The following are some guidelines to calculating benefits associated with energy costs, infrastructure costs, air emissions and employment trends.

Calculating Energy Cost Savings
Using factors for the cost of fuel (per litre, per kilowatt-hour, etc.) and, for transportation, average litres of fuel per kilometer, calculate total expenditures on energy in the Base Case and the CEP Case. The difference is the savings associated with the CEP measures. This analysis would be enhanced by detailed data on energy end-uses, travel characteristics, vehicle types and efficiencies, and commercial and freight transport, but it nonetheless provides a starting point for policy review purposes.

Calculating Infrastructure Cost Savings
If data has been collected on the unit cost of linear infrastructure services such as water, sewer, etc., the total cost may be calculated in each scenario either based on total lineal meters of service, or lineal meters per type of development, depending on the level of detail of the base data.

Calculating Emissions
Calculate air emissions using published emission factors (e.g., tonnes per unit of energy consumed) once the amount of energy consumed by fuel type and/or by transportation mode is known.

Calculating Employment Effects

Employment effects result from two sources:

1. Direct, indirect and induced employment from investments in the energy sector.

Investments in traditional supply will not lead to local job creation unless the community is located in an energy producing region. Investments in local supply will. In BC, investments in energy supply generate roughly 3.3 jobs per million dollars invested, including direct, indirect and induced jobs. Small-scale local resources likely produce more jobs, however not all of them will be local. Using a figure of 2-3 jobs per million dollars spent on local supply is likely to yield a reasonable estimate of the local employment effects of local supply.

Investments in energy efficiency generate roughly 13.6 jobs per million dollars invested. Calculate expenditures made by the community on energy efficiency measures, then multiply those by about 13 to get the total number of jobs created. Depending on community size and location, assume that between one third and one half of these are local.

2. Respending effects resulting from saving money on energy services.

If people are not spending money on energy, they will spend it on other goods and services. Energy services have a relative low job intensity (e.g., 3 jobs per million dollars spent) as compared to the job intensity of expenditures on a typical mix of consumer goods and services (e.g., 12 jobs per million dollars spent). After calculating the total annual cost of energy services for each of the Base and CEP scenarios, the respending effect is found by multiplying the cost difference by the final demand multiplier (e.g., 12 jobs / $million saved).

Step 5 Implementation

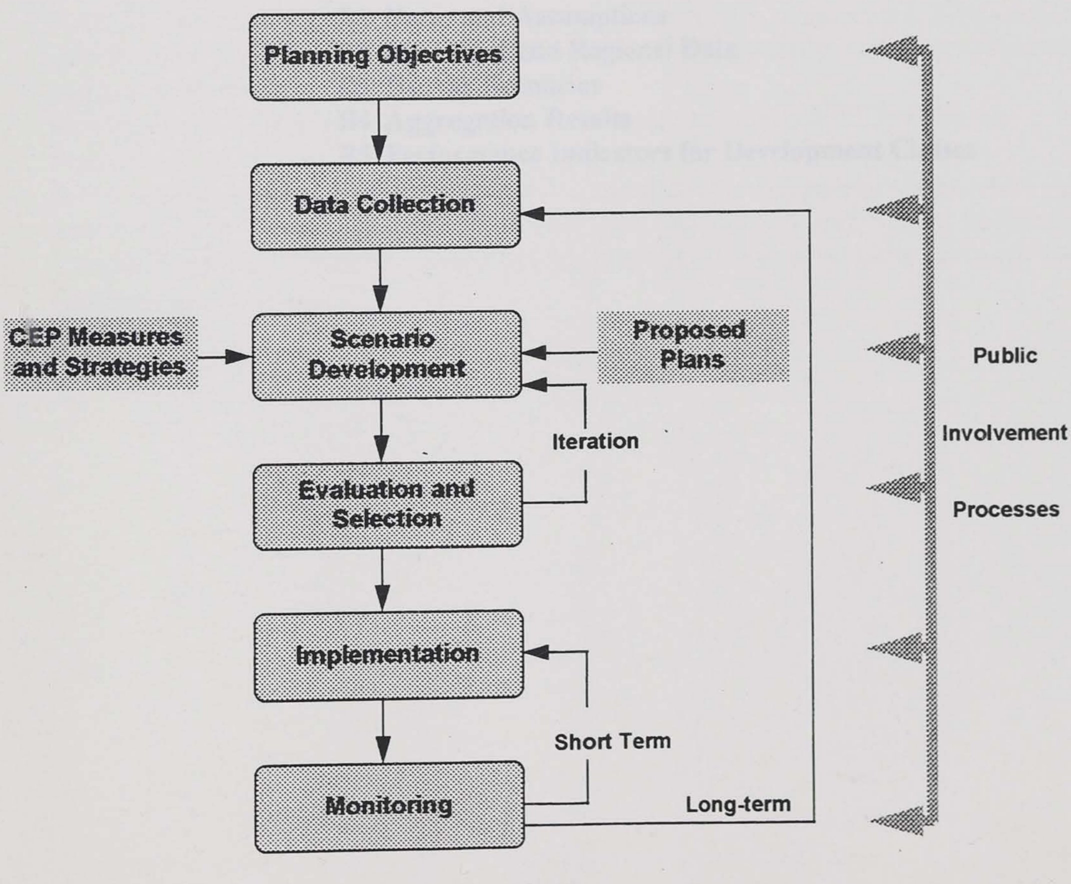
Based on the results of the first four steps of the CEP process, the community will develop an action plan for implementation. It should include a mix of instrument types (e.g., regulatory, economic incentives, information and public investment) as well as a mix of strategies from each sector (e.g., land use planning, transportation management, site and building design and alternative energy supply).

Step 6 Monitoring

Key indicators of performance are tracked over time. In the short term, monitoring results will lead to refinements to implementation strategies. In the long term, performance targets may be altered and new data requirements identified.

FIGURE A1

THE COMMUNITY ENERGY PLANNING PROCESS



APPENDIX B

MODELLING AGGREGATE EFFECTS

B1 Notes and Assumptions
B2 Municipal and Regional Data
B3 Density Scenarios
B4 Aggregation Results
B5 Performance Indicators for Development Classes

APPENDIX B1
Notes and Assumptions

- Per capita consumption figures are derived from the SFU Energy Research Group's 1995 study "Meeting Emission Reduction Targets in BC: Can We Do It?".
- Overall BAU emissions are calibrated with Natural Resources Canada figures and are within +/- 10%.
- Emissions from the electricity grid are calculated at 1990 levels. In reality, they should rise on a per GJ basis by 2010 due to increased percentage of electricity generated from fossil fuels. This simplifying assumption has the effect of reporting lower emissions overall, but has little effect on relative emission levels of CEP and BAU scenarios.
- Unit emissions for vehicles decrease by 25% from 1995 to 2010, reflecting a trend toward increased fuel efficiency.
- Technology and modal unit costs in 2010 are assumed equal in real terms to unit costs in 1995.
- Slight differences in the unit costs used for alternative technologies between the local and aggregate modelling exercises are the result of the time lag between the two studies. Costs used for the aggregate exercise (August 1995) reflect further refinements on the initial cost estimates used for the local case studies (October 1994).
- District heating costs are distributed on a per GJ basis over all heat and electricity output and assume that all heat and electricity produced is used.
- All buses are assumed in 1995 and 2010 to be fueled by diesel, and all autos on gasoline.
- Autos are composed of a composite of 40% fuel efficient, 40% average, and 20% vans. The definitions of "fuel efficient" etc. come from Litman (1990) at the Victoria Transport Institute and are North American figures.
- Municipal and regional data is derived from the Statistics Canada 1991 Housing and Population Census.
- Initial density conditions are based on preliminary information from interviews or GIS data from the City of Vancouver, North Vancouver City, City of Richmond, City of Burnaby and Langley Township, as well as information from the case studies in the cities of Prince George, Castlegar, and Surrey.

APPENDIX B2
Municipal and Regional Data

Regional District	Type	1991 Pop	Dwelling Units	Land Area	Gross Pop Density	Net Unit Density	Growth to 2010	2010 Pop
Vancouver	A	471,844	199,535	113	41.756	35.316	191,997	663,841
Burnaby	A	158,858	62,755	88	17.970	14.198	64,641	223,499
Victoria	A	71,228	36,295	19	37.887	38.612	22,198	93,426
Central Kootenay	A	51,073	20,215	23,237	0.022	0.017	8,208	59,281
New West	A	43,585	21,200	15	29.057	28.267	16,887	60,472
North Van City	A	38,436	18,220	11	34.942	33.127	12,516	50,952
White Rock	A	16,314	7,960	5	32.628	31.840	9,994	26,308
Esquimalt	A	16,192	6,915	7	24.167	20.642	878	17,070
Surrey	B	245,173	82,155	302	8.118	5.441	523,892	769,065
Richmond	B	126,624	44,460	124	10.212	7.171	101,088	227,712
Saanich	B	95,577	36,310	99	9.693	7.365	68,057	163,634
Port Coquitlam	B	36,773	12,110	27	13.620	8.970	52,529	89,302
Langley City	B	19,765	7,365	10	19.765	14.730	19,007	38,772
Oak Bay	B	17,815	7,660	11	16.807	14.453	3,167	20,982
Port Moody	B	17,712	6,185	23	7.701	5.378	8,711	26,423
Colwood	B	13,486	5,335	18	7.534	5.961	11,646	25,132
Sidney	B	10,082	4,455	5	20.164	17.820	5,532	15,614
Thompson-Nicola	C	104,386	39,335	44,872	0.023	0.018	34,479	138,865
RD Nanaimo	C	101,736	40,490	2,041	0.498	0.397	127,252	228,988
Fraser-Fort George	C	90,739	31,145	51,196	0.018	0.012	5,642	96,381
Dewdney-Alouette	C	89,968	30,630	3,155	0.285	0.194	150,310	240,278
Delta	C	88,978	28,825	168	5.296	3.432	46,966	135,944
Central Fraser Valley	C	87,360	29,840	385	2.269	1.550	159,944	247,304
Coquitlam	C	84,021	29,460	123	6.809	4.775	90,987	175,008
Comox-Strathcona	C	82,729	31,100	19,851	0.042	0.031	64,117	146,846
North Van DM	C	75,157	25,990	162	4.639	3.209	33,176	108,333
Fraser-Cheam	C	68,681	25,450	10,797	0.064	0.047	62,227	130,908
Okanagan-Similkameen	C	66,701	27,430	10,410	0.064	0.053	39,071	105,772
Langley DM	C	66,040	21,460	303	2.180	1.417	81,693	147,733
North Okanagan	C	61,744	23,430	7,830	0.079	0.060	35,182	96,926
Cariboo	C	61,059	21,245	69,168	0.009	0.006	6,256	67,315
Cowichan Valley	C	60,560	22,690	3,379	0.179	0.134	38,415	98,975
Peace River	C	53,317	18,585	109,540	0.005	0.003	5,245	58,562
East Kootenay	C	52,368	19,595	28,344	0.018	0.014	(2,732)	49,636
Kitimat Stikine	C	42,053	13,605	95,797	0.004	0.003	11,370	53,423
Columbia Shuswap	C	41,665	15,915	30,179	0.014	0.011	7,407	49,072
West Van	C	38,783	15,135	89	4.358	3.401	11,192	49,975
Bulkley-Nechako	C	38,000	12,630	72,101	0.005	0.004	3,430	41,430
CRD Subdivisions	C	34,488	14,865	667	0.517	0.446	32,950	67,438
Kootenay Boundary	C	31,194	12,395	7,907	0.039	0.031	3,451	34,645
Skeena-Q Charlottes	C	23,769	8,235	16,139	0.015	0.010	2,924	26,693
Squamish-Lillooet	C	23,421	8,435	16,533	0.014	0.010	41,738	65,159
Sunshine Coast	C	20,785	8,500	3,879	0.054	0.044	26,286	47,071
Powell River	C	18,477	7,225	5,101	0.036	0.028	425	18,902
Mt Waddington	C	13,896	4,885	21,464	0.006	0.005	(3,349)	10,547
Central Saanich	C	13,684	5,045	43	3.212	2.369	13,074	26,758
North Saanich	C	9,645	3,590	37	2.621	1.951	18,943	28,588
View Royal	C	5,925	2,310	11	5.436	4.239	5,698	11,623
Fort Nelson-Liard	C	5,038	1,635	82,560	0.001	0.000	(354)	4,684
University Endowment	C	4,534	1,555	14	3.239	2.221	6,279	10,813
Metchosin	C	4,232	1,390	71	0.599	0.393	2,990	7,222
Central Coast	C	3,482	1,130	25,122	0.001	0.001	1,802	5,284
GVRD Subdivision A	C	2,459	955	872	0.028	0.022	4,705	7,164
Stikine	C	2,153	820	116,143	0.000	0.000	(49)	2,104
Lions Bay	C	1,328	465	2	6.640	4.650	953	2,281
Anmore	C	741	270	5	1.482	1.080	4,228	4,969
Belcarra	C	586	210	3	1.953	1.400	164	750
TOTAL		3,126,419		880,575			2,295,433	5,421,852

Notes

1. Municipalities are represented with italics, regional districts with normal font.
2. All information is from Statistics Canada 1991 Housing and Population Census
3. Land area is all land within urban limits

APPENDIX B3
BAU and CEP Density Scenarios

BAU SCENARIO

ARCHETYPE	PROJECTED GROWTH	PORTION IN NODE		PORTION IN COMPACT		PORTION IN SPRAWL	
		%	Total	%	Total	%	Total
A	327,320	20%	65,464	40%	130,928	40%	130,928
B	793,629	5%	39,681	20%	158,726	75%	595,221
C	1,174,485	0%	-	10%	117,448	90%	1,057,036
Subtotal	2,295,433	5%	105,145	18%	407,102	78%	1,783,186
TOTAL	5,421,852	4%	221,049	18%	951,551	78%	4,249,253
TOTAL2	5,421,852	5%	273,621	20%	1,102,529	75%	4,045,702

CEP SCENARIO

ARCHETYPE	PROJECTED GROWTH	PORTION IN NODE		PORTION IN COMPACT		PORTION IN SPRAWL	
		%	Total	%	Total	%	Total
A	327,320	50%	163,660	50%	163,660	0%	-
B	793,629	30%	238,089	70%	555,540	0%	-
C	1,174,485	30%	352,345	70%	822,139	0%	-
Subtotal	2,295,433	33%	754,094	67%	1,541,339	0%	-
TOTAL	5,421,852	16%	869,997	38%	2,085,788	45%	2,466,067
TOTAL2	5,421,852	23%	1,247,044	46%	2,479,410	31%	1,695,397

TOTAL	Accounts for new growth only; i.e., assumes existing urban form remains unchanged.
TOTAL2	Assumes that 50% of nodal growth also converts compact to nodal form, and 50% of compact growth converts sprawl to compact form.

APPENDIX B4
AGGREGATION RESULTS

SPACE HEAT: Technology Market Shares

	District Heating	Waste Heat	Micro-cogen	Nat Gas	Elec Grid
Node	20.0%	10.0%	20.0%	37.5%	12.5%
Compact	10.0%	5.0%	5.0%	60.0%	20.0%
Sprawl	2.0%	0.0%	0.0%	73.5%	24.5%

SPACE HEAT: Technology Cost Multipliers

	District Heating	Waste Heat	Micro-cogen	Nat Gas	Elec Grid
Base $/GJ	*$ 12.70*	*$ -*	*$ 9.87*	*$ 7.71*	*$ 17.80*
Node	0.7	1.0	1.0	0.7	0.7
Compact	1.0	1.0	1.0	1.0	1.0
Sprawl	1.5	1.0	1.0	1.5	1.5

Notes:

Costs represent costs to the end-use; i.e., they are adjusted for end-use efficiency

Natural gas and grid electricity are priced at prevailing utility rates adjusted for end-use efficiency.

SPACE HEAT: Technology Emission Rates

	District Heating	Waste Heat	Micro-cogen	Nat Gas	Elec Grid
tonnes/GJ	0.0360	0.0000	0.0296	0.0710	0.0544

Notes:

Emission rates are adjusted for end-use efficiency.

ELECTRICITY: Technology Market Shares

	District Heating	Micro-cogen	Nat Gas	Elec Grid
Node	20.0%	20.0%	3.0%	57.0%
Compact	10.0%	5.0%	4.3%	80.8%
Sprawl	2.0%	0.0%	4.9%	93.1%

ELECTRICITY: Technology Cost Multipliers

	District Heating	Micro-Cogen	Nat Gas	Elec Grid
Base $/GJ	*$ 12.70*	*$ 9.87*	*$ 7.71*	*$ 17.80*
Node	0.7	1.0	0.7	0.7
Compact	1.0	1.0	1.0	1.0
Sprawl	1.5	1.0	1.5	1.5

Notes:

Costs are adjusted for end-use efficiency.

Natural gas and grid electricity are priced at prevailing utility rates adjusted for end-use efficiency.

ELECTRICITY: Technology Emission Rates

	District Heating	Micro-Cogen	Nat Gas	Elec Grid
tonnes/GJ	0.0360	0.0296	0.0710	0.0381

Notes:

Emission rates are adjusted for end-use efficiency.

TRANSPORTATION: Modal Shares
% of Total Kilometers Travelled

	Transit	Van Pool	Ped	Cycle	Auto
Node	30.0%	10.0%	10.0%	10.0%	40.0%
Compact	15.0%	10.0%	5.0%	5.0%	65.0%
Sprawl	5.0%	5.0%	2.0%	2.0%	86.0%

TRANSPORTATION: Modal Cost Multipliers
$ / Passenger Kilometer Travelled

	Transit	Van Pool Passger	Ped	Cycle	Auto
Base $/pkt	*0.2480*	*0.0001*	*0.0000*	*0.0566*	*0.1520*
Node	0.7	0.7	1.0	1.0	1.0
Compact	1.0	1.0	1.0	1.0	1.0
Sprawl	2.0	1.5	1.0	1.0	1.0

Notes:
"Auto" is a composite of 40% average auto, 40% fuel-efficient auto and 20% vans
Average vehicle occupancy of autos is 1.4, of vans is 10 and of buses is 12.
Base cost includes levelized capital, operating and maintenance costs.
PKT is passenger kilometers travelled

TRANSPORTATION: Modal Emission Rates

	Transit	Van Pool	Ped	Cycle	Auto
GJ/pkt	0.0018	0.0012	0.0	0.0	0.0031
kg/GJ	71.0	97.0	0.0	0.0	97.0
kg/pkt - 1995	0.1278	0.1164	0.0000	0.0000	0.3007
kg/pkt - 2010	0.0959	0.0873	0.0000	0.0000	0.2255

Notes:
Transit cost and emission data are for diesel buses.
Auto and Van cost and emission data are for gasoline fueled vehicles.
Energy Consumption per pkt is derived from the California Energy Commission's
Energy Aware Guide, 1993.
Emission rates in 2010 are 25% lower than 1995, reflecting a shift to more fuel-efficient vehicles.

COMPOSITE UNIT COSTS

	Space Heat $/GJ	Electricity $/GJ	Transportation $/PKT
Node	7.335	11.016	0.119
Compact	9.952	16.465	0.139
Sprawl	15.428	25.805	0.157

PER CAPITA CONSUMPTION DATA

	Space Heat GJ/capita	Electricity GJ/capita	Transportation pkt/capita
Base	*45*	*20*	*20000*
Node	0.88	0.88	0.70
Compact	1.00	1.00	1.00
Sprawl	1.18	1.18	1.44

Notes:

Base consumption data are derived from Energy Research Group (1995).

PKT reductions are assumed to be proportional to VKT reductions.

TOTAL PER CAPITA COST SUMMARY

	Space Heat $/cap/year	Electricity $/cap/year	Transportation $/cap/year	Total $/cap/year
Node	$ 290	$ 194	$ 1,660	$ 2,144
Compact	$ 448	$ 329	$ 2,777	$ 3,554
Sprawl	$ 819	$ 609	$ 4,512	$ 5,940

COMPOSITE UNIT EMISSIONS - 2010

	Space Heat t/GJ	Electricity t/GJ	Transportation t/PKT
Node	0.047	0.037	0.000128
Compact	0.059	0.039	0.000170
Sprawl	0.066	0.040	0.000203

TOTAL PER CAPITA EMISSIONS SUMMARY

	Space Heat t/cap/year	Electricity t/cap/year	Transportation t/cap/year	Total t/cap/year
Node	1.84	0.65	1.79	4.28
Compact	2.64	0.78	3.39	6.81
Sprawl	3.52	0.94	5.85	10.30

SCENARIOS: BAU and CEP

POPULATION BY DEVELOPMENT CLASS IN 2010

			BAU		CEP	
	%	Initial Population	%	2010 Population	%	2010 Population
Node	4%	115,903	4%	221,049	16%	869,997
Compact	17%	544,449	18%	951,551	38%	2,085,788
Sprawl	79%	2,466,067	78%	4,249,253	45%	2,466,067

SUMMARY OF COSTS AND EMISSIONS IN 2010

			BAU		CEP		Abatement Cost
	$/cap	t/cap	$ / year (Millions)	tonnes / year	$ / year (Millions)	tonnes / year	$ / tonne
Node	$ 2,144	4.28	$ 474	946,577	$ 1,865	3,725,512	
Compact	$ 3,554	6.81	$ 3,382	6,477,063	$ 7,413	14,197,645	
Sprawl	$ 5,940	10.30	$ 25,241	43,780,464	$ 14,648	25,408,129	
Total			**$ 29,096**	**51,204,104**	**$ 23,926**	**43,331,286**	
Savings					**$ 5,170**	**7,872,819**	**$ (657)**

APPENDIX B5
Performance Indicators for Development Classes

The following indicators suggest methods of measuring neighborhood attributes that are important for establishing development classes based on CEP principles. They are adapted from Holtzclaw (1994) but may be modified to suit individual communities.

Density

At the broadest level, the total population density of communities can be measured as:

$$\text{population density} = \frac{\text{total population}}{\text{total area}}$$

This indicator is most appropriate for large metropolitan areas or regional studies looking at the macro scale. However, it will not distinguish between regions of uniform sprawl and those with nodes of compact and dense development, perhaps separated by large tracts of greenspace. The low density of the latter may in fact enhance both livability and accessibility/efficiency attributes at the neighborhood scale. Two more useful indicators of density are:

$$\text{net population density} = \frac{\text{total population}}{\text{net residential area}};$$

$$\text{net residential density} = \frac{\text{total dwelling units}}{\text{net residential area}}.$$

Unfortunately, data on net residential area are very difficult data to obtain, both in BC and across North America (Holtzclaw, 1994). Depending on the community, net residential area may comprise from 1/2 to 1/5 of total urban area. Significant judgement is required in determining which areas are to be designated residential.

Mixed Use

Mixed use does not simply refer to the extent to which people live and work within a single neighborhood. In fact, this is quite difficult to achieve. Rather, the level of mixed use should suggest the extent to which those living in a neighborhood can access essential services within their neighborhood. A useful indicator is service job density, defined as:

$$\text{service job density} = \frac{\text{number of service jobs serving local needs}}{\text{net residential area}}$$

Holtzclaw (1994) suggests a more complex indicator termed a neighborhood shopping index, which measures the fraction of the community's population which has five critical local commercial establishments within a half kilometer walking distance. Critical local services are defined as food markets, restaurants and drugstores. Supermarkets count as two establishments. Neighborhood shopping is considered a surrogate for other services; that is, the existence of these five establishments suggests that other services such as drycleaners, accountants, real estate offices, video rentals and hairstylists may also be present. All of these also represent jobs. So the neighborhood shopping index is a measure of the existence of retail and other firms, and jobs within walking distance. It is defined as:

NSI = fraction of households within 1/2 km of 5 key commercial establishments.

In the absence of operational and well-populated GIS, planners will most likely have to walk the communities under consideration in order to establish the NSI.

Pedestrian Accessibility Index

This index measures neighborhood qualitites which make a community inviting and safe to walk in. It considers continuous street grids, gentle street slopes, sidewalks, convenient building entrances, and controlled traffic. It is defined as:

$$\begin{aligned}\text{PEI} = {} & \text{(fraction of through streets)(fraction of roadway below 5\% grad)(.33)} \times \\ & \text{[(fraction of blocks with walks, each side)+(building entry coefficient)+} \\ & \text{(fraction of streets with traffic controlled)];}\end{aligned}$$

where

$$\text{Building Entry Coefficient} = \begin{cases} 1.0 \text{ if 0-1 m setback from walk;} \\ 0.5 \text{ if 1-3 m setback from walk;} \\ 0.3 \text{ if 3-7 m setback from walk;} \\ 0.1 \text{ if 7-12 m setback from walk;} \\ 0.0 \text{ if} > \text{12 m setback from walk.} \end{cases}$$

Transit Accessibility

To measures a community's access to transit, Holtzclaw established a transit accessibility index, defined as:

$$\text{TAI} = \frac{\sum\text{(buses both directions/day)(seats/bus)(\%households to 1/2 km)}}{\text{(50 seats / standard bus)(24 hours/day)}}$$

$$+ \frac{\sum\text{(railcars both directions/day)(seats/car)(\%households to 1 km)}}{\text{(50 seats/standard bus)(24 hours/day)}}$$

APPENDIX C

CASE STUDY AT WESTMINSTER QUAY

C1 Technical and Cost Assumptions
C2 Next Steps for the Westminster Quay Project

APPENDIX C1

TECHNICAL AND COST ASSUMPTIONS

Data	
Interest Rate	8%
Life, years	20
Cogeneration Unit	
Electrical Capacity, kW	1,000
Availability	98%
Electrical Output, kwh/yr	8,584,800
Fuel Consumption, BTU/hr	9,500,000
Thermal Capacity, kW	1,600
Thermal Output, kWh	13,735,680
Stand-By Boiler	
Capacity, mmBTU/hr	2.0
Efficiency	87%
Energy Demands	
Estimated Thermal Energy Load, GJ	32,166
Cogen Unit Capital Cost, $/kW	$ 1,200
Cogen Unit Initial Investment, $	$ 1,200,000
Back up Boiler Capital Cost, $/mmBTU/hr	$ 9,000
Boiler Capacity, mmBTU/hr	2.00
Boiler Initial Investment, $	$ 18,000
Installation Costs (Piping etc for space heat)	$ 6,000,000
Total Initial Investment, $	**$ 7,218,000**
Avoided Cost, $/unit	$ 3,000
Number of Units	$ 1,000
Central Distribution Equipment and Peripherals, $	$ 1,000,000
Total Avoided Cost, $	**$ 4,000,000**
Net Initial Investment	**$ 3,218,000**

Annual Costs	Rate $/...	kWh	mmBTU	kW	Total
O&M, $/kwh	$ 0.013	8,584,800			$ 111,602
Fuel, Cogen unit, $/mmBTU	$ 4.00		81,556		$ 326,222
Fuel, Boiler, $/mmBTU	$ 4.00		8,958		$ 35,832
Stand-by / Demand Charges, $/KW	$ 56.00			1,000	$ 56,000
Total Annual Costs, $/year					**$ 529,657**

Annual Revenue	
Estimated Electrical Demand, kWh	8,584,800
Residential Electricity Rate, $/kwh	$ 0.063
Estimated Electricity Sales, $	$ 540,842
Avoided cost of electric heat	
Estimated space heat demand, kWh	11,427,600
Electricity Rate ($/kWh)	$ 0.063
Total avoided heating bill, $	$ 719,939
Estimated Heating Revenue	$ 719,939
Total Annual Revenue	**$ 1,260,781**
Net Annual Cash Flow	**$ 731,124**
Net Present Value @ 8%	**$ 3,521,690**
Internal Rate of Return	**22%**
Simple Payback (years)	**4.4**

Assumptions:

The entire electrical output of the cogeneration unit is used.
A 2.0 mmBTU/hr natural gas boiler will meet peak thermal demands.
The boiler meets 20% of total thermal demand over the year.
The remaining thermal demand is met by the cogeneration unit, representing 66% of its thermal capacity.
Boiler efficiency = 87%.
The value of heat sales may rise up to the avoided cost of electric heat.
Heat provided by both boiler and cogeneration unit is saleable.
Stand-by charges are those currently proposed by BC Hydro Rate Schedule 1884 and 1885.

APPENDIX C2
Next Steps for the Westminster Quay Project

In the case of the Westminster Quay Project, the rezoning process is in its final stages and the introduction of cogeneration to the talks at this late stage is a challenge. However, there is still an opportunity for a negotiated solution. The cogeneration project outlined in this study represents a significant business opportunity, for either the developer or the municipal utility. Even in the absence of a rezoning application, multi-party negotiations - including as a minimum, the developer, the equipment supplier, the municipal utility (electrical department), BC Hydro and BC Gas - should identify a strong potential for a win-win situation. Local government has nothing to lose by initiating such a process, but much to gain. The project supports long term community sustainability objectives - both economic and environmental - and helps the municipality meet its commitments to provide innovative approaches to the provision of services and to ensure that new developments adhere to the principles of energy efficiency.

The following are suggested as a guideline for some next steps to consider with respect to the Larco development specifically:

- Form a task force to address the issue. The task force should include, at minimum, members from: New Westminster Electrical Department, City Planning Department, City Environment Committee, City Council, BC Hydro, BC Gas, the developer, and representation from the community.
- Request presentations and initial estimates from equipment suppliers on alternative technologies and their applications. As a minimum, these should include microcogeneration and water source heat pumps.
- Review the technical and cost implications on building design and construction with Larco's architects/engineers.
- Identify the environmental implications of each option, including the base "do nothing" case.
- Identify any technical concerns arising from the engineering department, the municipal utility, BC Hydro and BC Gas with respect to the potential installation.

If agreement is reached to pursue the opportunity:

- Investigate the need to renegotiate the municipal utility's purchase contract with BC Hydro to reflect the fact that the municipality may be involved in small scale distributed generation applications. Alternatively, if it is the developer who will sell the electricity, apply for exemption from the Utilities Commission Act.
- Negotiate stand-by charges with BC Hydro.
- Negotiate a bulk gas rate with BC Gas.
- Issue a Request for Proposals for energy systems including, at minimum, microcogeneration and heat pump technologies.

If no agreement is reached:

- Establish a review process within the Environment Committee to review the impact of new developments having significant energy requirements.
- Investigate the possibility of increasing utility hook-up fees for the use of electrical resistance heaters in new development.
- Investigate the possibility of introducing the requirement for energy efficient design into the final stages of the rezoning negotiations.

APPENDIX A

MODELLING LOCAL EFFECTS

A1 Detailed Methodology
A2 CEP Case Studies and Results
A3 Modelling Assumptions and Output
A4 Community Energy Planning Guide

APPENDIX A1
Detailed Methodology

A1.1 BUILDINGS

Overview
Current residential building stock is established with data collected from the city planning department for the numbers of dwelling units. Some city offices have only limited data on commercial floorspace. Where local data was unavailable, it was estimated from the Conservation Potential Review data (Marbek, 1993).

Heating loads per housing type were calculated using averages from the CPR study. The non heating load is estimated by assuming that heating requirements make up 81% of all residential energy consumption (64% space heat plus 17% water heating). These estimates are used for all communities. BC Hydro regional data for Prince George was used to reference the average consumption of various housing types. These were found to be consistent with the CPR and other estimates for energy consumption per housing type in terms of relative intensities

The BAU and CEP scenarios are based on the same assumption for growth rate and the initial heating and non heating load is the same for each scenario.

Demand-Side Management
In the residential sector, the percentage of growth that is accommodated in each type of housing is input exogenously reflecting municipal policy. A resulting density effect is calculated which indicates the savings in energy that result from moving to an alternative mix of housing types. Only the heat energy saving is calculated.

In both residential and commercial sectors, it is assumed that all new buildings are constructed with consideration of passive solar and microclimate design features. Energy savings suggested in the literature range from 10-40% for passive solar and 5-15% for microclimate. At 10% and 5% respectively, the values used in this study are conservative. The penetration of solar hot water heating varies among community types, reflecting decreased cost-effectiveness as a result of local climatic considerations.

In the commercial sector, it is assumed that 40% of office and retail space are located in mixed use developments, and that 30% of the heat load of the affected commercial space is available as waste heat to the residential sector.

The savings due to conventional DSM in the BAU scenario is based on ISTUM[1] natural run simulations which indicate that an overall reduction in base energy intensity of 15% can be expected. This is split between general DSM (10%) and conversion efficiency improvements (4%). The CEP scenario assumes that through implementation of the policy packages, municipalities are successful in removing barriers to greater penetration, such that reductions in base energy intensity can be increased to 30%, or half of the economic potential as reported by the CPR I study and confirmed by the CPR II study findings (SRC, 1994).

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[1] Intra-Sectoral Technology Use Model: An energy end use model developed at Simon Fraser University that simulates consumer response to price and technology evolution.

Supply Calculations

For district heating systems, no detailed engineering calculations for optimization of plant sizing were performed; standard capacities at 10 megawatt increments were considered, with a standard heat to power ratio. The same is true for the proposed cogeneration plant from the combustion of biogas on sewage facilities. Surrey's multi-fueled power plant is taken directly from Moffat (1992). For heat pumps generally, penetration rate varies by climatic suitability, reflecting variability in coefficient of performance (efficiency) and hence cost-effectiveness.

The proportion of energy supplied by the grid and natural gas mains is calculated by splitting the remaining demand at the same relative share as the base and BAU scenarios. Transmission losses are not accounted for.

A1.2 TRANSPORTATION AND LAND USE

BAU assumes that all growth is accommodated in the peripheral residential developments, according to recent and projected trends. Average trip distance increases accordingly. In the CEP, 30% of growth is accommodated within redeveloped core areas, with the remaining 70% located in contiguous developments close to central facilities. Average trip distance declines accordingly.

Modal shift to HOV is based on a presumed increase in vehicle occupancy from 1.1 to 1.2 - 1.4 depending on the community. Number of household trips per day is based on the Energy Council's suggestion that this may be as high as 10 per household. The trend to rising auto dependence in BAU results in a slight rise, while in CEP a slight decline reflects modal shift toward transit and pedestrian/bicycling. Average distance is based on the weighted average distance to regional shops.

In the CEP scenario, alternative fuel vehicles are expected to penetrate to a level of 10% of all commuter and casual trips. No attempt is made to distinguish among the alternative fuels currently competing for shares in the emerging market. Instead, a composite is assumed, consisting of one third natural gas, one third propane, and one third electric. Increases in fuel efficiency are not considered.

Transit data is from BC Transit. Some communities will not experience enough growth to increase density sufficiently to meet currently accepted threshold density limits for cost effective transit, however it is assumed that through the increased use of more innovative and flexible transit solutions, including small vans, taxi ride share programs etc., moderate modal share improvements could still be realized. The calculations assume that this increase will achieved by increasing transit frequency and also operating costs by four times. Clearly this is a simplified calculation which ignore the complexities involved in transit planning. "Across-the-board" frequency increases are likely to increase costs by a ratio of more than one to one. Instead, a cooperative effort between city and transit officials is required to identify key leverage routes. Most likely these will be in and around the mixed use nodes, and on selected peak hour express routes from viable residential areas.

A1.3 COST

The costs of supply technologies are calculated based on a life-cycle cost (LCC) analysis at a social discount rate of 7%. LCC for supply technologies in general does not include the end user's equipment cost, although for district heating, LCC does include connection costs. The implicit assumption is that equipment costs are roughly equal for all supply technologies.

Calculations are based on 1994 prices for relatively mature technologies (e.g., gas engines, heat pumps) and on forecasts for 2000 for those expected to undergo rapid development in the next few years (e.g., photovoltaics). For electricity from the grid and natural gas from gas mains, only the rate charged by the utility is used in calculating costs. The rate is assumed to be constant in real terms over the 15 year period, reflecting the current trend to converging marginal and average costs. (BC Hydro, 1994)(RCG, 1994).

Use of microclimate is assumed to be costless. This is true for lot orientations etc., but may not hold completely for the use of vegetation and landscaping. Increased density has a negative cost due to decreased cost of housing. The life-cycle costs of demand-side management measures are drawn from simulation runs of the ISTUM model at Simon Fraser University.

For local supply systems, LCC is calculated based on the standard formula:

$$LCC = \frac{CC\,(CRF) + \Sigma AC}{\text{Energy Output}}, \quad \text{where } CRF = \text{Capital Recovery Factor} = \frac{1}{1-(1+r)^{-n}}$$

CC = Capital Costs ($)
AC = Annual Costs ($)
r = Social Discount Rate (7%)
n = Technology Lifetime (years)

For cogeneration technologies, LCC is calculated as the average cost considering all energy output, i.e., (Total $) / (GJe + GJth). This is justified on the basis of a social cost analysis rather than a financial perspective.

A1.4 EMPLOYMENT INDICATORS

Employment effects accrue from two sources:

1. Direct, indirect and induced employment from investments in the energy sector.
2. Respending effects resulting from saving money on energy services, and spending it instead in areas of greater job intensity.

According to Sims (1991), investments in energy supply in BC generate roughly 3.3 jobs per million dollars invested. This includes direct, indirect and induced jobs. Demand-side management (DSM) technologies in the electricity sector generate roughly 13.6 jobs per million dollars. For this study, the 3.3 is assumed to apply to both major electricity grid and gas main investments and to local supply options. The 13.6 figure is applied to both electricity and gas DSM investments. After calculating the total annual cost of energy services for each of the BAU and CEP scenarios, the respending effect is found by multiplying the cost difference by the final demand multiplier of 12 jobs / $million, which assumes that savings are spent in typical consumer fashion.

Half of all jobs created as a result of expenditures in DSM are assumed to be created in the local economy. All of the jobs that result from investments in imported supply are assumed to be non-local. Half of all jobs from the "local" supply options are assumed to occur locally. All respending effects are assumed to result in employment in the local economy.

In Anahim Lake, it is recognized that fewer goods and services are available locally. Economic multipliers published by Davis (1986) for different regions in BC were used to scale down local effects accordingly. A factor of 0.8 was used reflecting the ratio of multipliers for the North region to the Lower Mainland region.

A1.5 MUNICIPAL ACCOUNTS

This calculation identifies opportunities for savings in operating costs as a result of community energy planning initiatives. It does not identify all effects; rather, it is a threshold analysis intended to show that enough savings exist that it is "worth doing anyway".

1. Municipally owned buildings. It is assumed that investments in energy efficiency reduce energy costs by 35-50% (Goldberger, 1993). Savings are based on identification of the number, square footage and current energy bills of municipally owned buildings.
2. Road Maintenance: This includes repaving and lane additions, but not new road construction. Savings are estimated by converting annual expenditures in 1994 to a dollar per kilometer figure, and comparing total kilometers of road expected in the BAU vs. CEP scenarios.
3. Snow Removal and Street Cleaning: As above.
4. Transit: Savings in transit expenses are based on increasing costs four fold, while achieving improvements in ridership. Ridership targets vary among communities. Transit savings are calculated only for Prince George and Castlegar. For Surrey, the integrated nature of the system made such analysis prohibitively complex.
5. Water and Wastewater Pumping Energy: This does not include efficiency measures in the pumping or treatment facilities themselves. It includes an estimation of savings that accrue as a result of the difference in urban form in the BAU vs. CEP scenarios. It is assumed that pumping energy is directly related to friction losses associated with additional pipe length. While this may be somewhat generous, no account is taken of the costs associated with the construction of additional lift and valve stations, so the estimation remains conservative.
6. Power Plant Revenue: For wood waste this is calculated based on the model developed for the BC Energy Council's Wood Utilization Project. Revenue is calculated net of taxes and interest payments. Electricity is assumed to be sold at $0.056/kwh, which represents an approximate average of electricity sold locally at $0.063/kwh locally and excess electricity sold back to the utility at $0.04/kwh. Heat services are assumed to be sold at a rate equal to the rate paid by customers receiving heat services from natural gas. Only one half of available heat is sold in the Castlegar scenario for lack of customers. Surrey's multi-fueled power plant is taken directly from Moffat (1992) which calculates revenue based on an assumption that natural gas will be purchased at the bulk rate and sold to customers at retail rates.
7. Reductions in lot servicing costs are based on Frank (1989).

Program implementation costs are largely outside the scope of this study, however some general assumptions can be made. The process of rezoning land uses is assumed to be costless, as are additions to existing approval processes. Taxes and tolls are suggested in the policy packages, but not quantified due to the need for detailed study. Nor are capital costs of bicycle paths and pedestrian walkways explicitly calculated, however it is assumed that they are more than compensated by decreased expenditures in road construction.

APPENDIX A2
CEP Case Studies and Results

A2.1 City of Prince George

Community Profile
Prince George is a resource based community that has grown into a major regional service centre in the north of the province. Population in 1994 is roughly 72,000 and is expected to grow by 1.2-1.5 % per year over the next 10-20 years. With three pulp mills and 15 sawmills, the economy is said to revolve around "wooden dollars". The forestry industry directly employs over 6500 people with a further 16,000 employed in forestry-related service jobs. Other significant employers include chemical plants and the new University of Northern BC.

Energy Profile
The city and surrounding area currently depend on imported resources for virtually 100% of energy requirements. In the building sector, energy comes from the electricity grid and natural gas mains, and in the transportation sector, gasoline dominates. A small and declining percentage of light fuel oil, propane and wood heating systems are employed in the building sector but are considered negligible in this study. There are significant sources of wood waste in the Prince George region, as well as a Phase I[1] beehive burner, indicating that the potential exists to utilize wood waste for a community energy system. The city is subjected to severe winter conditions over eight months of the year.

Urban Form
Prince George is a low density community. The large remaining undeveloped area within city limits leads to a perception that land is unlimited and there is little public support for increasing density or urbanization. This suggests that in a business-as-usual scenario, Prince George's growth pattern is likely to follow that of typical urban sprawl, with increasing dependence on the private automobile for transport.

A Business-as-Usual Future
Typical single family oriented residential subdivisions continue to open up in the southwest and north sections of the city in spite of increasing costs to the town for servicing and maintaining such non-contiguous development. Single family homes represent 70% of all new dwellings constructed, street orientations are increasingly trending toward curvilinear streets and cul de sacs, and no consideration is given in laying out lot orientation to optimize solar gain. Of the multifamily homes constructed, the majority are constructed with electric baseboard heating units which decrease the economic potential for district heating in the future. Overall urban density continues to decline, dropping off to less than 8 people per hectare by 2010.

The downtown revitalization project is limited to a short stretch of 3rd Avenue. The private automobile continues to be the main mode of transport to and from the downtown core. In fact the access provided for pedestrians becomes the source of conflict as traffic increases over time and there is pressure to widen the roadway. By 2010 increasing traffic on the Highway 97 bypass has created congestion on the north-south connector and a conflict builds between commuters and

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[1] Phase I burners are those that must be phased out by December 1995.

highways planners who want to expand the capacity at a cost of several million dollars, and neighboring landowners who do not want more traffic, noise and smog in their area. There are demands for multi-million dollar overpasses at the 5th and 15th avenue interchanges.

A Future with Community Energy Planning

The downtown revitalization project begins with the redevelopment of 3rd Avenue, but it is complemented by an aggressive strategy to encourage redevelopment throughout the downtown core. A revenue-neutral differential taxation structure which taxes land heavily relative to buildings has the effect of making it very expensive to keep vacant land within the core area, and encourages vertical expansion. The abundance of one and two-level buildings downtown in 1994 is gradually converted into three and four level mixed use structures, through the provision of low interest loans and multiple incentive packages. Comprehensive development contracts governed by a performance point system[2] , are negotiated with developers to ensure that residential, commercial, cultural, recreational and transportation services are all integrated into plans from the beginning.

While most of the growth in the next fifteen years is accommodated within the valley bottom area, it is recognized that a market remains for a more rurally oriented type of lifestyle. In an effort to accommodate this demand without incurring undue environmental or financial costs, the city opens up the Harper Valley area to development. The area is located near the downtown core, along a major transit corridor. The central feature of the development is a clustered residential development, nestled in a partially forested environment with access to a large natural open space. Two and three level units with heavily insulated shared walls, gables, sloped roofing, chimneys, courtyards, offset entrances and professional landscaping provide the best in energy efficiency while still protecting individual privacy and aesthetics.

Overall growth is accommodated as outlined in section 3.1.1. Increased traffic pressures on the main north-south connector are accommodated by turning one lane into an HOV lane during peak hours. Transit priority traffic signals are provided at congestion locations. Any additional road construction takes the form of addition of cycling lanes, bike racks, and wider sidewalks. Street trees and furniture in mixed use nodes and along strategic connectors help encourage pedestrian traffic. The costs of such measures are more than offset by reduced expenditures on conventional road maintenance and construction.

A large percentage of the work force in Prince George is employed by a few large employers. Thus, requiring that all businesses employing 50 or more employees institute an Employee Trip Reduction Program will affect a significant number of commuters. Because of the cold climate and consequent limitations on walking, cycling and transit as options, the emphasis is on increasing vehicle occupancy. However, in the valley bottom, transit remains a viable option, and the frequency of transit service in the valley bottom and along commuter routes is increased by four times, with a more flexible fleet makeup.

Site and building design measures follow those outlined in the policy package section 2.2.3.

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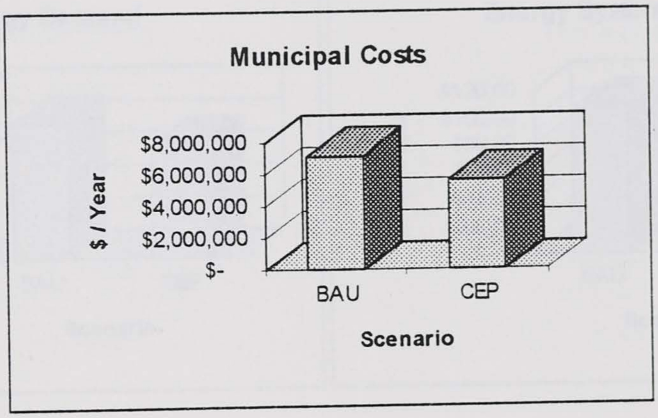
[2] A portfolio of preferred characteristics of the development are itemized, with points allocated to each. Examples include bus shelters, bike paths, reduced street widths, some threshold amount of greenspace, passive solar design in buildings, etc. Development proposals must receive a minimum number of points before approval of the project.

After December 1998, there is an abundance of wood waste available that can no longer be incinerated in beehive burners according to provincial regulation, and sawmills are willing to pay to have their waste removed. Wood waste thus becomes the energy source for a combined heat and power plant established under the jurisdiction of a municipal utility. A district heating zone is established per section 2.2.4.

Results

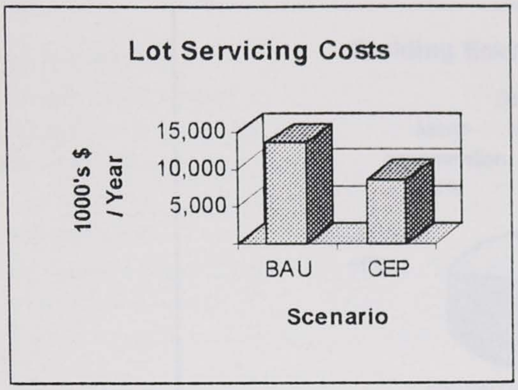
A Municipal Perspective

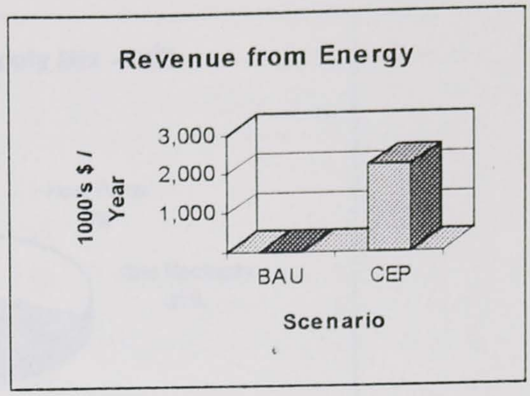
Savings in municipal operating budgets in the CEP scenario amount to over $1.5 million annually. These are realized as a result of reductions in building energy costs, fleet fuel costs, net transit costs, road construction and maintenance, and the pumping costs of water and wastewater systems. Transit operating costs increase threefold, however increased revenue from increased ridership goes directly to offset the municipality's share of the cost, with a net decrease in the municipality's cost. The quantified costs represent only a small portion of actual savings that might be achieved. Substantial savings could also be expected from reductions in the costs associated with road accidents, policing, and fire protection services. As well, it can be expected that increased expenditures on facilities for walking, cycling and transit would be more than offset by decreases in road infrastructure costs.



The actual costs of new infrastructure are in some cases borne by the municipality and in some borne by the developer. In the latter case, these costs do not directly affect municipal budgets, however, they are passed on to the home buyer. So it is significant to note that in the community energy planning scenario, savings in lot servicing costs of at least 30% will be achieved, amounting to roughly $4.9 million annually in 2010.

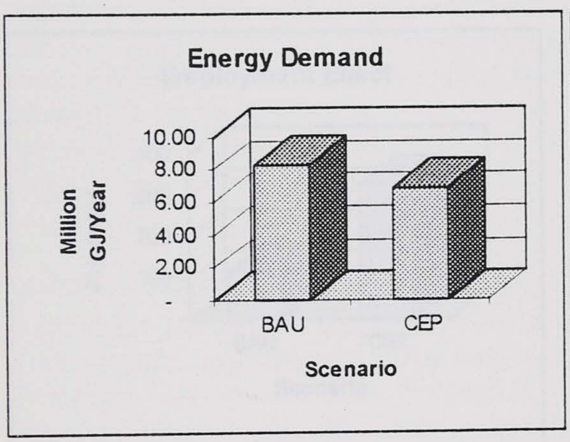
The sale of energy services by a municipally owned utility results in net income, after tax and after interest payments, of roughly $2.2 million per year. Revenue from taxes on fuels are excluded under the assumption that a municipal franchise tax on district heat will be calculated to replace lost revenue from existing taxes on other fuels. The analysis assumes that excess electricity is purchased by the BC Hydro, and that wood waste is available at a credit to the municipality as sawmills are willing to pay for disposal.

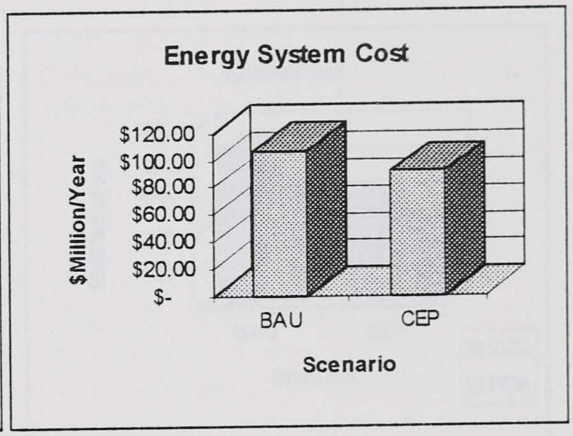




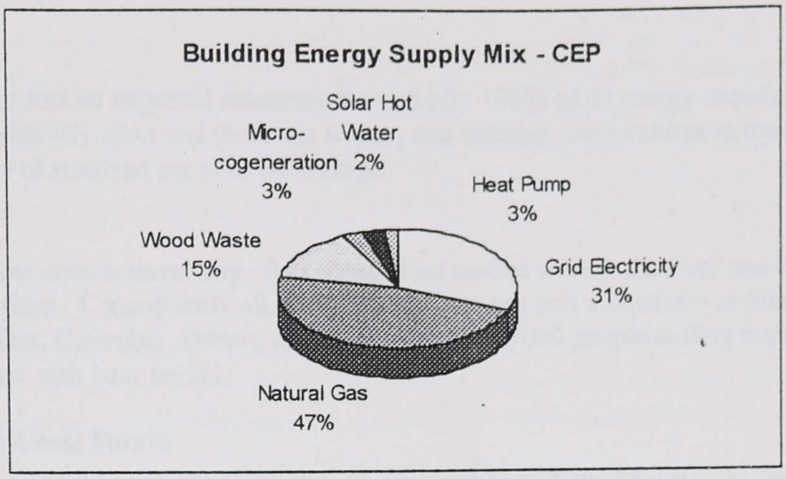
A Community Perspective

Dramatic reductions in energy consumption are achieved as a result of increased conservation efforts, use of passive solar and microclimate, use of more efficient energy conversion technologies, and the utilization of waste heat in mixed use developments. Consumption relative to the business-as-usual scenario is roughly 17% lower. The total cost of energy services is 15% lower than that in the business-as-usual scenario. This represents over $15 million annually.



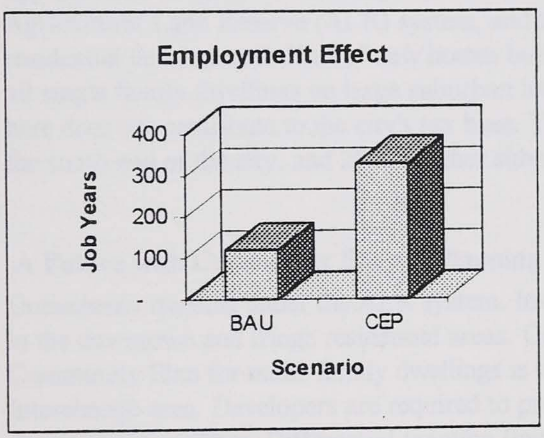


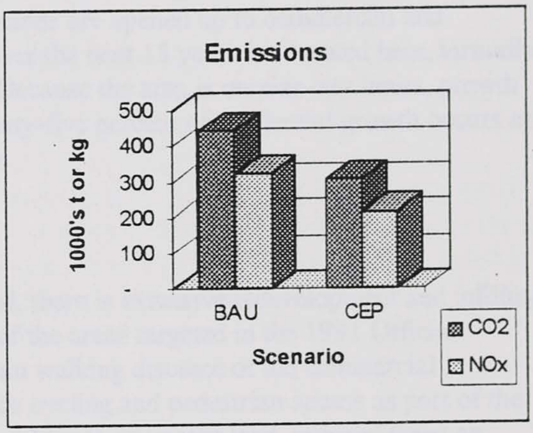
In the CEP scenario, over 20% of all building energy is provided through local supply sources (heat pumps, micro-cogeneration, solar hot water and wood waste). In BAU, all building energy is provided from the grid and natural gas mains.



23% Local Supply

Investments in efficiency and local energy resources tend to create jobs locally. Investments in the energy system in 2010 create nearly twice as many local jobs in the community energy planning scenario relative to business-as-usual. Much of this employment is created as a result of investments in local energy resources.





Community energy planning dramatically reduces emissions of carbon dioxide and nitrous oxides in 2010 - over 30% reduction. For nitrous oxides, this assumes that the wood waste plant displaces a beehive burner. If it did not, nitrous oxides would rise slightly in the CEP scenario.

A2.2 City of Castlegar

Community Profile

The city of Castlegar is located in the southern interior of BC, midway between Vancouver and Calgary. It is the focal point of three major highways: No. 3, 3A and 22. It is a hub of timber operations in southeastern BC, with the forest products industry directly employing over 700 people. Centrally located in the West Kootenay, Castlegar is growing in importance as a regional warehousing, distribution and servicing centre. Today the population within the urban limits of Castlegar is roughly 7000, reaching 15,000 in the surrounding district. While growth stagnated through the eighties, it is expected to rise to 2.5% to 3% per year as Lower Mainland growth pressures overflow into the region.

Energy Profile

The city is dependent on imported resources for virtually 100% of its energy requirements. It experiences a relatively short and moderate winter, and extreme temperatures in the summer, with over 1800 hours of sunshine per year on average.

Urban Form

Castlegar is a low density linear city. It is constrained on one side by the river and on the other by steep mountainsides. Consequently all traffic - city, inter city and industrial - is funneled onto one main thoroughfare, Columbia Avenue, and this city of only 7000 people suffers traffic congestion over a significant rush hour period.

A Business-as-Usual Future

In response to increased congestion, the City, in partnership with the Ministry of Transportation and Highways, expands the width of Columbia Avenue at a cost of $4.5 million dollars to the City and $14.0 million for Highways. A further collector road is constructed at a cost to the City of $2.7 million.

The Central Kootenay Regional District succeeds in having Ootischenia (a large flat area on the opposite side of the river currently outside the city limits of Castlegar) removed from the Agricultural Land Reserve (ALR) system, and the lands are opened up to commercial and residential development. Half of new homes built over the next 15 years are located here, virtually all single family dwellings on large suburban lots. Because the area is outside city limits, growth here does not contribute to the city's tax base. Twenty-five percent of residential growth occurs at the south end of the city, and 25% in other suburbs.

A Future with Community Energy Planning

Ootischenia remains under the ALR system. Instead, there is extensive redevelopment and infilling in the downtown and fringe residential areas. One of the areas targeted in the 1991 Official Community Plan for multi-family dwellings is within walking distance of the commercial Interchange area. Developers are required to provide cycling and pedestrian access as part of the development contract. Differential taxation (increased taxes on vacant land, reduced taxes on buildings), financial mechanisms (low interest loans) and other incentives succeed in facilitating the subdivision of existing over-size lots in other areas. Thirty percent of all new residential and commercial growth occurs in the downtown and fringe area. One and two level buildings are converted to multi-story mixed use structures.

At the south end of town, a comprehensive development contract is negotiated with the developers such that they must incorporate both residential and commercial uses in an aesthetically pleasing manner, provide cycling and pedestrian access, and include energy efficiency measures in the site design -- including passive solar and use of microclimate. Streets are laid out in a grid pattern for improved access, with wider sidewalks and traffic calming features. Lots sizes are reduced by reducing the set back from the street. Clustered single family dwellings, creatively designed to maintain neighborhood character and individual privacy, reduce lot servicing costs and energy consumption, increase available greenspace and help to foster a sense of community.

One lane on Columbia Avenue is a dedicated HOV lane during peak hours. No increases in street width are undertaken, except to improve cycling and pedestrian access. Cycling facilities along Arrow Lakes Road are provided, serving two of the city's larger employers. All businesses employing 50 or more employees are mandated to institute an Employee Trip Reduction Program. This is assumed to affect roughly 50% of commuters, including over 300 who commute 27 km to Cominco in Trail. This is phased in, beginning with businesses with over 100 employees initially.

The existing transit fleet is augmented with smaller, more fuel efficient and flexible vehicles. Transit frequency is increased by four times, and coupled with express routes and HOV lanes, transit becomes the most efficient way to travel to the downtown area. Park and Ride facilities are provided for intercity traffic. Neighboring municipalities -- namely the Castlegar-Trail-Nelson triangle -- recognize the parallels between the distances and travel patterns among their communities and those among some of the Lower Mainland communities. This recognition sets the stage for planning for intercity transit catering to commuters and shoppers in the years to come. The distances involved are not unlike those between Vancouver-Surrey-Abbotsford. Thus over perhaps a 20-30 year planning period, it is not unrealistic to envision a time when inter-community transit is viable and preferable.

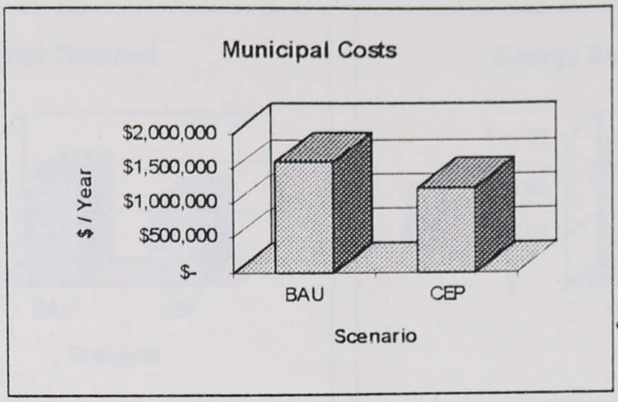
The site and building design measures proposed for Castlegar are as defined in section 2.2.3. An emphasis is placed on programs that encourage heat pumps and solar hot water heaters.

The city creates a district energy zone which encompasses those neighborhoods considered for ultimate inclusion in a district energy system - namely the "Transition" and "Special Residential" zones near the Interchange area. Special measures for density, diversity, rate of growth and site standards are applied. By 2010, a combined heat and power plant is established under the jurisdiction of a municipal utility, which provides district heating services and electricity to local homes and businesses and sells excess power to West Kootenay Power. The plant is fueled by local wood waste, available at a credit to the local utility as a result of provincial regulations requiring phase out of beehive burners and appropriate disposal of wood waste by 1998.

Results

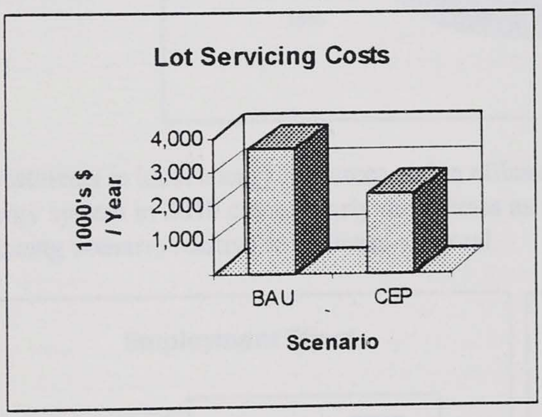
A Municipal Perspective

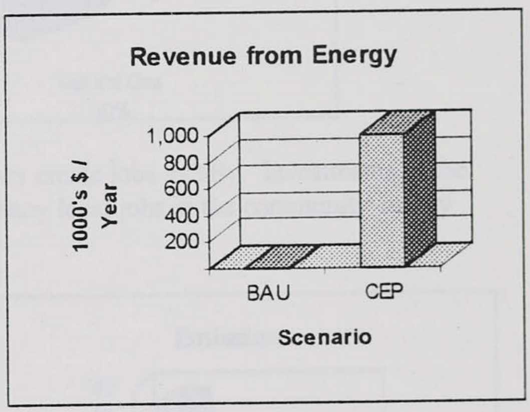
Savings in municipal operating budgets are nearly $400,000 per year. They are realized as a result of reductions in building energy costs, fleet fuel costs, net transit costs, road construction and maintenance, and the pumping costs of water and wastewater systems. These represent only a small portion of actual savings that might be achieved. Substantial savings could also be expected from reductions in the costs associated with road accidents, policing, and fire protection services. As well, it can be expected that increased expenditures on facilities for walking, cycling and transit would be more than offset by decreases in road infrastructure costs.



The actual costs of new infrastructure are in some cases borne by the municipality and in some borne by the developer. In the latter case, these costs do not directly affect municipal budgets, however, they are passed on to the home buyer. So it is significant to note that in the community energy planning scenario, savings in lot servicing costs of at least 30% will be achieved, amounting to roughly $1.3 million annually in 2010.

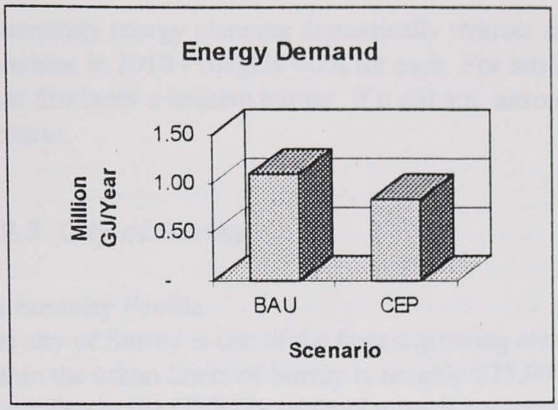
The sale of energy services from a municipally owned utility results in net income, after tax and after interest payments, of nearly $1.0 million per year. Revenue from taxes on fuels are excluded under the assumption that a municipal franchise tax on district heat will be calculated to replace lost revenue from existing taxes on other fuels. This assumes that the city is able to attract at least one large heat customer, in addition to expected residential and commercial customers, to purchase up to one quarter of the available heat. Without that customer, revenue would drop off significantly, but remain positive.

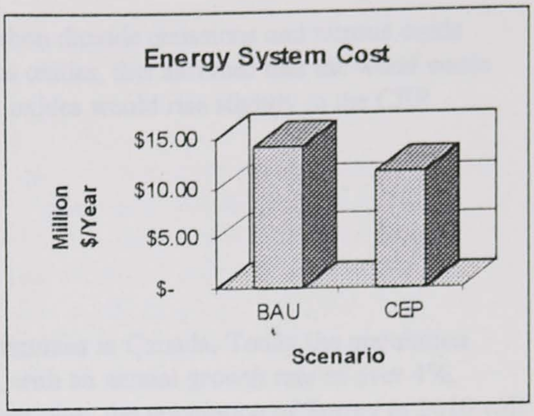




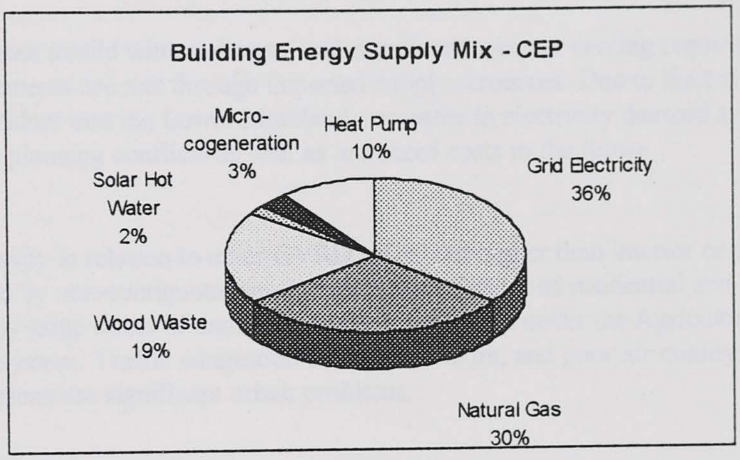
A Community Perspective

Dramatic reductions in energy consumption are achieved as a result of increased conservation efforts, use of passive solar and microclimate, use of more efficient energy conversion technologies, and the utilization of waste heat in mixed use developments. The total cost of energy services in 2010 is 18% lower in the CEP scenario relative to the BAU scenario, representing savings of roughly $2.6 million annually. This is achieved on a reduction in energy consumption of 23%.

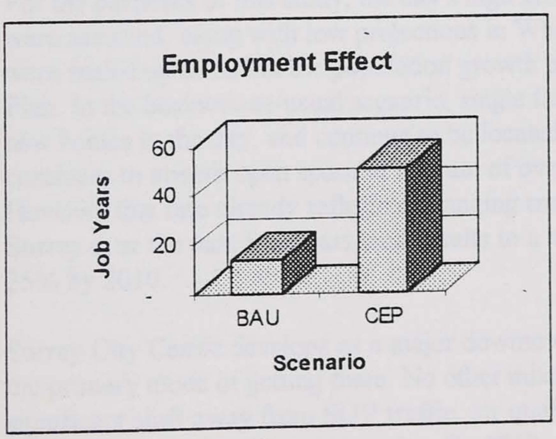


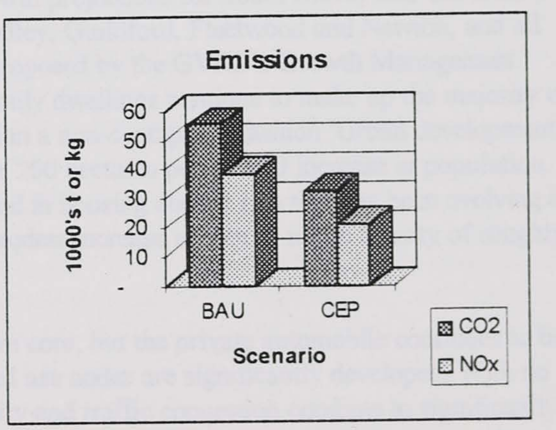


In the CEP scenario, over one third of all building energy is provided through local supply sources (heat pumps, micro-cogeneration, solar hot water and wood waste). In BAU, all building energy is provided from the grid and natural gas mains.



Investments in local energy resources and in efficiency create jobs locally. Investments in the energy system in 2010 create nearly three times as many local jobs in the community energy planning scenario relative to business-as-usual.





Community energy planning dramatically reduces carbon dioxide emissions and nitrous oxide emissions in 2010 - roughly 40% for each. For nitrous oxides, this assumes that the wood waste plant displaces a beehive burner. If it did not, nitrous oxides would rise slightly in the CEP scenario.

A2.3 City of Surrey

Community Profile
The city of Surrey is one of the fastest growing communities in Canada. Today the population within the urban limits of Surrey is roughly 275,000, with an annual growth rate of over 4%. According to the GVRD's regional growth management plan, the population of Surrey in 2010 will be in the order of 650,000. In relation to other GVRD cities, Surrey is comparatively underdeveloped in the commercial and industrial sectors, however it has land available for such development.

Energy Profile
The city experiences a mild winter climate, and significant summer cooling requirements. Virtually all energy requirements are met through imported supply resources. Due to limited access to transmission corridors into the Lower Mainland, increases in electricity demand are likely to cause difficult land use planning conflicts as well as increased costs in the future.

Urban Form
Surrey is low density in relation to other GVRD cities, but higher than interior or northern cities. It is characterized by non-contiguous development, with developed residential and commercial areas separated by large tracts of undeveloped land, some of it under the Agricultural Land Reserve (ALR) system. Traffic congestion in the peak hours, and poor air quality as a result of automobile emissions are significant urban problems.

A Business-As-Usual Future

A multiplicity of planning alternatives are currently on the table in the city planning department. For the purposes of this study, the city's high growth projections for South Surrey and Cloverdale were assumed, along with low projections in Whalley, Guildford, Fleetwood and Newton, and all were scaled up to reflect the population growth proposed by the GVRD's Growth Management Plan. In the business-as-usual scenario, single family dwellings continue to make up the majority of new homes in the city, and continue to be located in a non-contiguous fashion. Urban development continues to absorb open space at the rate of over 200 hectares per 12,000 increase in population. However this rate already reflects a changing trend in housing and lot size that has been evolving in Surrey over the past few years, and results in a modest increase in overall urban density of roughly 25% by 2010.

Surrey City Centre develops as a major downtown core, but the private automobile continues to be the primary mode of getting there. No other mixed use nodes are significantly developed. With no significant shift away from SOV traffic, air quality and traffic congestion combine to significantly lower the livability of the community. By 2010, conflicts arise over transmission corridor rights, as Lower Mainland electricity demand exceeds the capacity of existing transmission lines.

A Future with Community Energy Planning

The original plans for Surrey City Centre are complemented by increased emphasis on mixed use, transit, pedestrian and bicycle access, and local supply. Significant sources of heat and energy are identified, and a district heating zone is established. Outside the downtown core, two areas in Fleetwood and Newton are also targeted for intensive redevelopment and infilling, with an emphasis on the creation of smaller, moderate density, mixed use nodes. One and two level buildings are converted to multi-story mixed use structures. Thirty percent of all growth is accommodated in and around these mixed use areas.

Comprehensive development contracts are negotiated with the developers such that they must incorporate both residential and commercial uses in an aesthetically pleasing manner, provide extensive and continuous cycling and pedestrian access, provide wider sidewalks and traffic calming features, design for efficient transit access, and include energy efficiency measures in the site design, including residential clusters, passive solar design and use of microclimate. Lots sizes are reduced by reducing the set back from the street. Clustered single family dwellings, creatively designed to maintain neighborhood character and individual privacy, reduce lot servicing costs and energy consumption, increase available greenspace, and help to foster a sense of community.

No new increases in SOV capacity are provided. Traffic congestion problems are dealt with by the designation of HOV lanes and by imposing tolls on high use connectors and bridges. No increases in street width are undertaken, except to improve cycling and pedestrian access. All businesses employing 50 or more employees are mandated to institute an Employee Trip Reduction Program. The program is phased in, beginning with businesses with over 100 employees initially. Parking charges are instituted where they do not exist and increased by at least 50% where they do. A sliding pay scale encourages HOV's.

The existing transit fleet is augmented by smaller, more fuel efficient and flexible vehicles for low-density areas. Coupled with express routes, transit priority signals and HOV lanes, transit becomes the most efficient way to travel to mixed use nodes. Park-and-ride facilities are provided for intercity traffic. Savings in road construction are reallocated to transit, park-and-ride and cycling facilities.

The site and building design measures proposed are as outlined in section 2.2.3. Greater emphasis is placed on programs that encourage heat pumps and solar hot water heaters, and solar photovoltaics. An office of technology assessment and financial assistance for renewable technologies such as solar, wind and heat pumps is established to assist homeowners and businesses to overcome the barriers associated with new technologies.

The city creates a district energy zone which encompasses Surrey City Centre. Special measures for density, diversity, rate of growth and site standards are applied. A combined heat and power plant is established under the jurisdiction of a municipal utility, which provides district heating and cooling services and electricity to local homes and businesses, and sells excess power to BC Hydro. The plant is fueled by multiple sources including local wood waste (15%), natural gas (40%), river cooling, 10%, industrial waste heat (22%) and a heat pump on city sewage (15%) (Moffat, 1992).

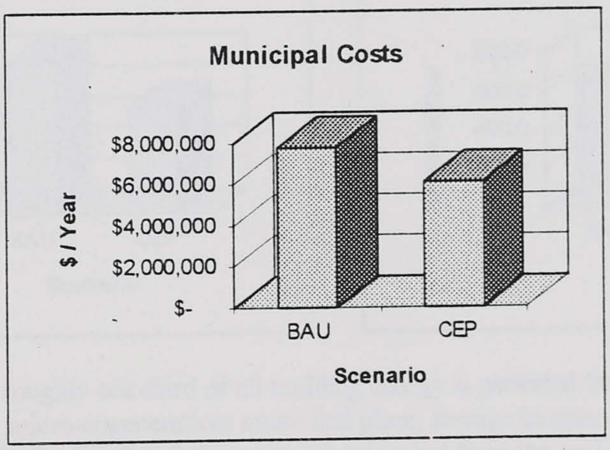
A second district energy zone is set up northwest of Surrey City Centre. A 5 megawatt cogeneration plant with district heating is constructed on the Annacis Island sewage treatment facilities to serve the area. Planners may look for opportunities to site an industrial heat source on the route to boost hot water temperatures for future expansion.

The city works in partnership with BC Hydro to establish a solar "village", which incorporates buildings designed from the ground up to accommodate roof-top solar panels, including optimal roof pitch and solar access, as well as maintenance access and connections to the electricity grid. The system benefits the utility by providing an alternative to costly additions to transmission capacity, and it benefits the community by providing an environmentally benign energy source and preserving green space that would otherwise be compromised by transmission corridors.

Results

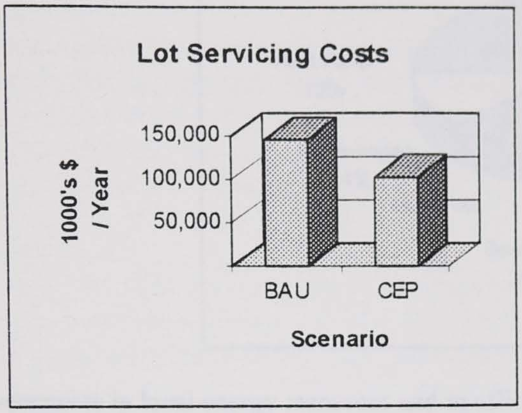
A Municipal Perspective

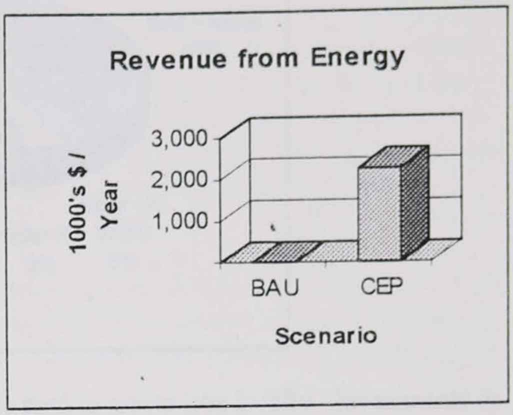
In the CEP scenario, savings in municipal operating budgets of roughly $2 million are identified. The savings are realized as a result of reductions in building energy costs, fleet fuel costs, road construction and maintenance, and the pumping costs of water and wastewater systems. However, this is clearly an underestimation. Fleet figures for example were available for passenger vehicles only, and building energy expenses appear much too low, suggesting that not all were identified. Due to the complexity of the integrated transit system, transit ridership improvements were not considered. The quantified costs represent only a small portion of actual savings that might be achieved. Substantial savings could also be expected from reductions in the costs associated with road accidents, policing, and fire protection services.



The actual costs of new infrastructure are in some cases borne by the municipality and in some borne by the developer. In the latter case, these costs do not directly affect municipal budgets, however, they are passed on to the home buyer. So it is significant to note that in the community energy planning scenario, savings in lot servicing costs of at least 30% will be achieved, amounting to over $43 million annually in 2010.

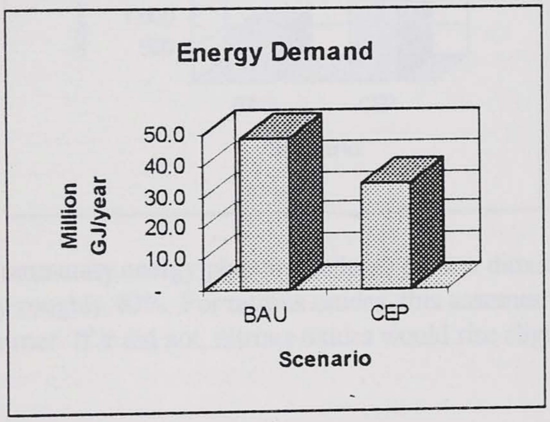
The sale of energy services from a municipally owned utility results in net income, after tax and after interest payments, of roughly $2.2 million per year (Moffat, 1992). Revenue from taxes on fuels are excluded under the assumption that a municipal franchise tax on district heat will be calculated to replace lost revenue from existing taxes on other fuels.

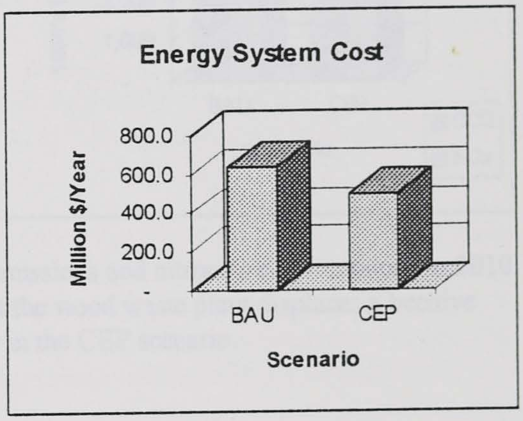




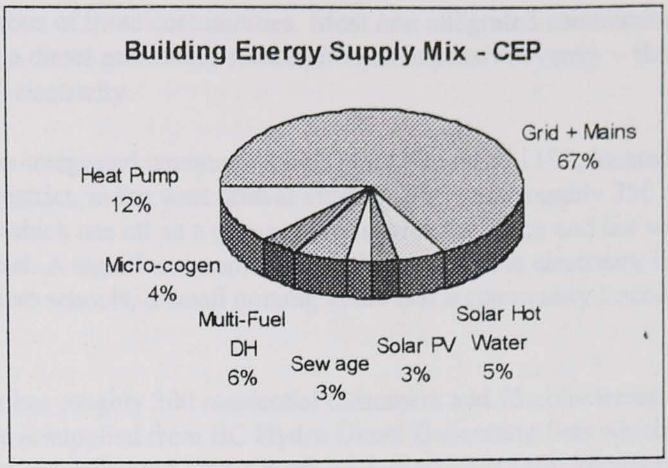
A Community Perspective

Dramatic reductions in energy consumption are achieved as a result of increased conservation efforts, use of passive solar and microclimate, use of more efficient energy conversion technologies, and the utilization of waste heat in mixed use developments. Energy consumption in CEP relative to BAU is nearly 30% lower, and the total cost of energy services is reduced by 22%. This represents over $138 million annually, or roughly $250 per capita.

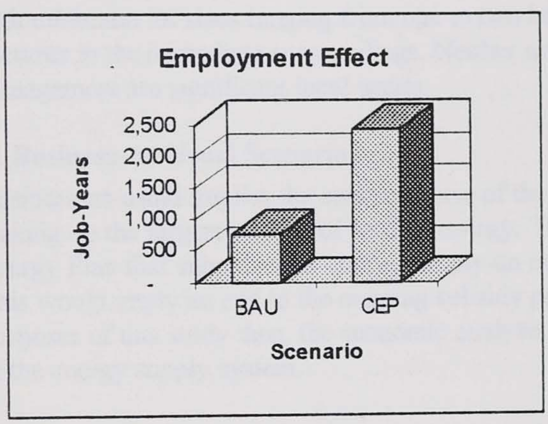


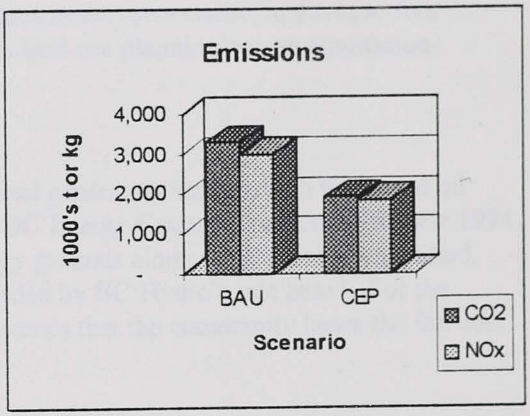


In the CEP scenario, roughly one third of all building energy is provided through local supply sources (heat pumps, micro-cogeneration, multi-fuel plant, sewage biogas, solar hot water, and solar photovoltaics). In BAU, all building energy is provided from the grid and natural gas mains.



Investments in local energy resources and in efficiency tend to create jobs locally. Investments in the energy system in 2010 create over twice as many local jobs in the community energy planning scenario relative to business-as-usual.





Community energy planning reduces carbon dioxide emissions and nitrous oxide emissions in 2010 by roughly 40%. For nitrous oxides, this assumes that the wood waste plant displaces a beehive burner. If it did not, nitrous oxides would rise slightly in the CEP scenario.

A2.4 Anahim Lake

Community Profile

Non integrated communities are communities that are not linked to a natural gas delivery system or to the electricity transmission grid. There are some forty of them in the province, ranging in population from 20-odd seasonal workers to permanent settlements of over 3000 people. Located in remote or inaccessible regions, the lack of a reliable and affordable energy supply is seen as a major obstacle to local economic development.

The cost of replacing or providing new energy supply is higher for non-integrated communities than anywhere else in the province. What this means is that non-conventional technologies that are not normally considered economically competitive elsewhere may constitute creative alternatives for the unique conditions of these communities. Most non integrated communities receive their energy services from a diesel generating station. It is an expensive system -- three to five times more costly than grid electricity.

Anahim Lake is a non-integrated community with a population of 1100, located in the Cariboo-Chilcotin Regional District, in the west central interior. There are roughly 350 dwellings in the community, most of which use oil as a primary fuel source for space and hot water heating, with wood as a back up fuel. A significant number of mobile homes use electricity for space and water heating. There are two schools, a small nursing clinic and a community learning centre.

Energy Profile
Currently BC Hydro has roughly 300 residential customers and 75 commercial customers in Anahim Lake. Power is supplied from BC Hydro Diesel Generating Sets which put out roughly 6000 megawatt hours annually, and meet a peak load of roughly 1500 kilowatts. Electricity sales are anticipated to grow at roughly 4% annually.

Urban Form
While relatively compact by small community standards, Anahim Lake is still very low density, with minimum lot sizes ranging from one to two hectares in the town centre, and two to four hectares in the immediate surroundings. Neither urban land use planning nor transportation management are significant local issues.

A Business-As-Usual Scenario
Business-as-usual implies the continued use of the diesel generating station, with wood and oil making up the largest portion of heating energy. The BC Energy Council emphasizes in their 1994 Energy Plan that subsidies for energy supply on energy grounds alone are generally unjustified. This would imply an end to the ongoing subsidy provided by BC Hydro's rate base[3]. For the purposes of this study then, the economic analysis assumes that the community bears the full cost of the energy supply system.

By 2010 in a business-as-usual scenario, energy consumption has grown to 10,000 megawatt hours per year with a peak of over 2500 kilowatts -- a 65% growth in peak since 1994. Equipment and fuel are purchased from external suppliers; money spent on energy goes straight out of the community without any local linkages or respending effect to boost the local economy. Further, the system is not an environmentally friendly one; it has significant emissions of sulfur and carbon dioxides, nitrous oxides and particulate.

A Future with Community Energy Planning
It is apparent that many of the strategies associated with urban land use planning and transportation management are of limited relevance in Anahim Lake and most other non-integrated communities[4]. Land use planning in Anahim Lake is done in the offices of the Cariboo Regional

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[3] BC Hydro's non integrated systems incur generation costs in the range of 15 to 25 c/kilowatt hour, while electricity is charged at 6c/kilowatt hour. Thus a subsidy is provided by the larger ratepayer base of roughly 10-20c/kilowatt hour.

[4] CORE initiated a local area plan in the region, however its primary focus is to address trade-offs among natural resources -- forestry, mining, protected areas etc.

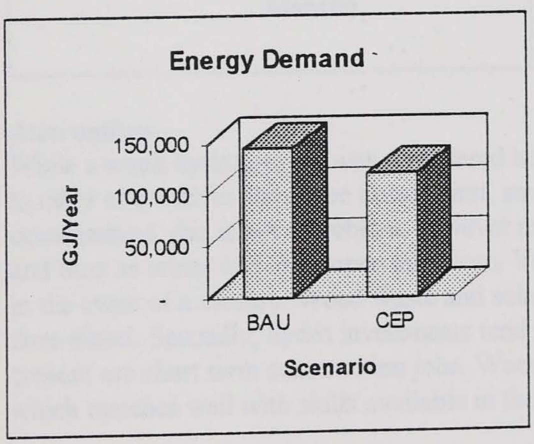
District planning department, five hours away. Transportation is not under the active jurisdiction of any central planning authority. While the general principles of defining a strict urban boundary and zoning for moderate densities and mixed uses remain desirable strategies for the long-term, transportation and land use planning measures were not modelled in this study. The effects of such measures are likely to be felt only over much extended time frame. The scenarios that follow therefore focus on the supply side options and demand-side management.

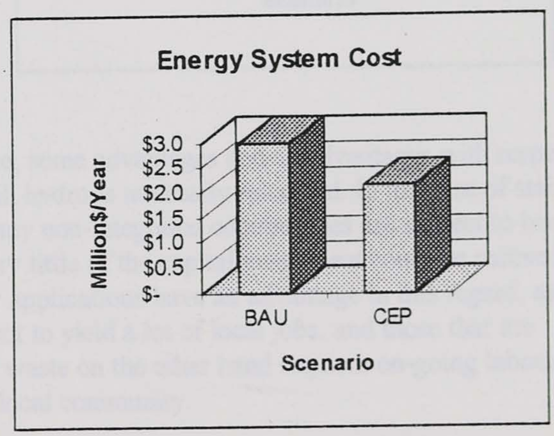
From 1994 to 2010, demand-side management initiatives contribute significantly to reducing the costs of supply alternatives by reducing the peak load. For capital intensive local supply options, this dramatically improves the economic picture. In partnership with the utility, financial incentives -- with an emphasis on providing access to capital -- are made available for improved insulation in electrically heated homes, high efficiency lighting and appliances, and solar hot water systems. By 2010, public education in peak reduction measures, investments in more efficient technologies, the use of passive solar and microclimate design principles in the construction of new homes, and the penetration of solar hot water heaters in one quarter of homes, have succeeded in reducing the peak load.

On the supply side, there are many technical options that deserve consideration. Studies have shown that there is potential for small hydro and wood waste generation. When the backstop price is the avoided cost of diesel generation, a multitude of options become viable, including solar or wind electricity systems. Without a site-specific study it is impossible to know which option would prove to be the most cost effective. However, under the assumption that a suitable site exists, which has been suggested by an independent project proponent at the latest BC Hydro rate hearings, small hydro has been selected for comparison. The costs have been calculated for a typical under-10 megawatt installation, plus the costs of lengthy transmission lines from the site.

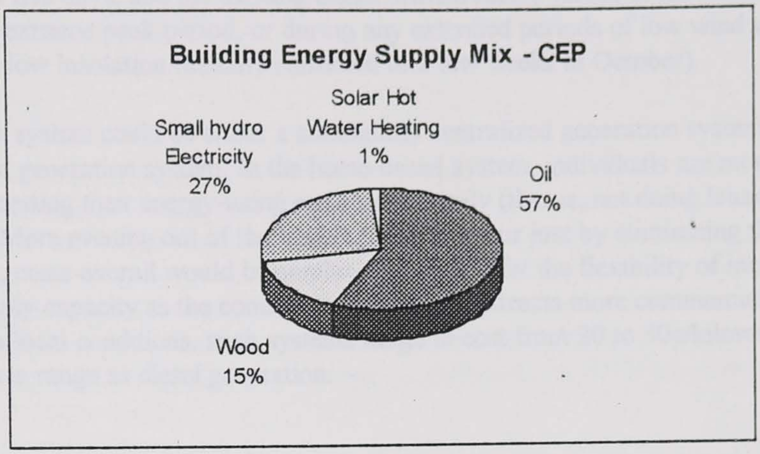
Results

As a result of an emphasis on improved efficiency, passive solar and microclimate design features, and increased financing mechanisms, total energy consumption drops roughly 17%. Peak load also drops relative to business-as-usual, remaining below 2000 kilowatts. Without subsidies of any kind applied, the total system cost of the small hydro system, calculated on a life-cycle cost basis, is 31% lower than the diesel generation system, for savings of over $700 per year per capita.

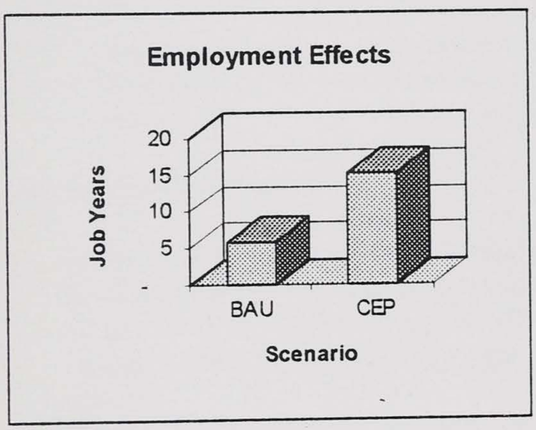


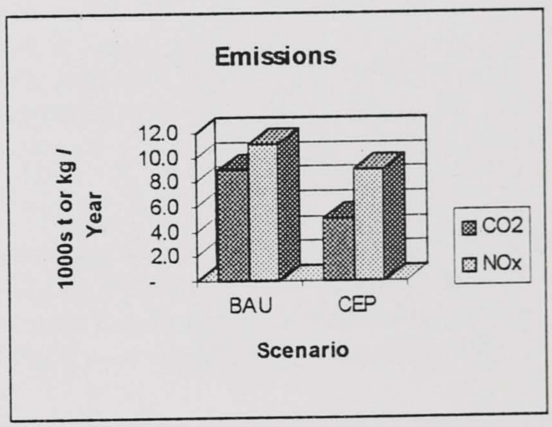


In the CEP scenario, 43% of building energy is provided through local sources (wood, small hydro, solar hot water), versus 15% (wood) in BAU.



In recognition that in very small communities, fewer goods and services are available locally, as well as fewer skilled workers, employment effects were scaled down. Nonetheless, based on the respending effect alone (resulting from reduced costs of energy services), 1.6 times more job years are realized in the CEP scenario. Dramatic reductions in emissions result from displacing diesel. Only carbon dioxide and nitrous oxides are shown, but similar reductions could be expected for sulfur dioxides and particulate matter as well.





Alternatives

While a small hydro project was considered here, some advantages and disadvantages with respect to other alternatives should be noted. First, small hydro is not easily relocated. In the case of stable communities, this is not a problem, however many non-integrated communities are subject to boom and bust as mines and mills open and close. Very little of the capital investment could be recovered in the event of a closure. Wood waste and solar applications have an advantage in this regard, as does diesel. Secondly, hydro investments tend not to yield a lot of local jobs, and those that are created are short term construction jobs. Wood waste on the other hand requires on-going labour, which matches well with skills available in the local community.

Many communities may not have access to resources such as small hydro or wood waste. For these communities, it is interesting to look briefly at other renewable alternatives. For example, a hybrid photovoltaic and wind powered system may provide primary power for all but 4-6 weeks of the year (personal communication, E. Auerbach, Energy Alternatives). A battery bank provides storage for up to five days, and the existing diesel infrastructure serves in the initial years as backup to cover extreme peak period, or during any extended periods of low wind speed accompanied by low insolation (usually restricted to a few weeks in October).

Interestingly, the system could be either a community centralized generation system, or a home-based distributed generation system. In the home-based system, individuals are more likely to be conscious of operating their energy-using equipment wisely (that is, not doing laundry at peak demand times). More evening out of the load is likely to occur just by eliminating the "commons" effect. However, costs overall would be similar, and both offer the flexibility of incremental additions to supply capacity as the community grows and attracts more commercial interests. Depending upon local conditions, such systems range in cost from 20 to 30c/kilowatt hour, the same approximate range as diesel generation.

APPENDIX A3
Modelling Assumptions and Output

A3.1 CITY OF PRINCE GEORGE

Land Use Planning

- Average trip length is reduced from 6.5 to 5.2 kilometers.
- The density of the downtown core is increased to nearly 50 people per hectare.
- 20% of total commercial space is in mixed use; 20% of heat used in that space is available to the residential sector as waste heat.
- Costs of infrastructure services are reduced by 30% per lot by locating new development contiguous to existing development, near to central facilities and employment centres, and by including multi-family housing types in equal proportion to single family conventional and single family cluster units.

Transportation Management

- Increase in the average commuter vehicle occupancy from 1.1 to 1.4 persons per vehicle.
- All municipal and fleet vehicles, and 10% of individual vehicles are converted to alternate fuel vehicles.
- The combination of transportation management and land use planning measures allows a modal shift to occur:

Transit	From less than 1% to 4%
Pedestrian/Cycling	From less than 2% to 5%
Auto HOV	From less than 5% to 12%
Auto SOV	From more than 92% to 79%

Site and Building Design

- Assume that the availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and existing buildings.
- All new buildings achieve savings of 10% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling and vegetative wind shielding.
- 25% of all homes use solar hot water heaters to meet 70% of hot water heating requirements per home.

Alternative Supply

- Roughly 12% of the city's energy load is expected to occur in the downtown core and be served by a district heating system.
- 20% of all new commercial buildings utilize distributed generation via natural gas engines with waste heat recovery.
- Heat pumps penetrate to only a limited degree due to the extreme climate (roughly 3%).
- The remainder is supplied by the natural gas and electric grid systems in proportions equal to those in 1994.

CITY OF PRINCE GEORGE

PRIMARY INDICATORS

		BAU	CEP
MUNICIPAL ACCOUNTS			
Operating Expenses	$/year	$ 7,194,050	$ 5,631,867
Annual Infrastructure Costs	$/year	$ 13,493,234	$ 8,586,604
Annual Net Revenue: Municipal Utility	$/year	$ -	$ (2,200,000)
SOCIO-ECONOMIC			
Percentage of Energy from Local Sources	%	0%	20%
Local Job Years from Energy Investment		117	337
ENVIRONMENTAL			
Total CO2 Emissions	t/year	444,974	307,502
Total NOx Emissions	t/year	324,427	218,140
ENERGY			
Total Energy Consumption	GJ/year	8,306,909	6,756,986
Total Annual Cost of Energy	$/year	$ 107,471,420	$ 91,646,942
Per Capita Annual Cost of Energy	$/cap/year	$ 1,176	$ 1,003

RESIDENTIAL SCENARIOS

	Units	BAU TOTAL	SFD	MFD	APT	CEP TOTAL	SFD	MFD	APT
Base Stock	No.	26,250	20,378	1,666	3,606	26,250	20,378	1,666	3,606
Base Energy Intensity Total	GJ/unit		115.0	75.0	40.0		115.0	75.0	40.0
Base Energy Intensity Heat	GJ/unit		93.2	60.8	32.4	-	93.2	60.8	32.4
Base Energy Intensity Non-heat	GJ/unit		21.9	14.3	7.6	-	21.9	14.3	7.6
Annual Increment	%	0.015				0.015			
No.of New Units by 2010		7,061				7,061			
Percent of each housing type			75%	15%	10%		50%	30%	20%
No.of new units each housing type			5,296	1,059	706		3,530	2,118	1,412
No each type total stock		32,711	25,674	2,725	4,312	32,711	23,908	3,784	5,018
Total Heat Demand	GJ	2,696,764	2,391,501	165,552	139,712	2,619,553	2,227,071	229,894	162,589
Total Non-Heat Demand	GJ	632,574	560,969	38,833	32,772	614,463	522,399	53,926	38,138
Total Building Energy Residential	GJ	3,329,338	2,952,470	204,385	172,483	3,234,017	2,749,470	283,820	200,727
DENSITY EFFECT									
Reduction in heat load	%	Caused by shift to multi-family dwellings				2.9%			
Reduction in total energy load	%					2.9%			
Total Energy Saved by density	GJ					95,322	2.9% of total		
PASSIVE SOLAR EFFECT									
% Heating Reduction	%					10.0%			
Total Heat Energy Saved	GJ	Assume it affects all new homes				50,330	1.6% of total		
Total non heat energy saved	GJ	Assume it affects all new homes				2,485			
% Savings on Lighting	%					20%			
MICROCLIMATE EFFECT									
% Heating Reduction	%	Assume it affects all new homes				5.0%			
Total htg energy saved by microclimate	GJ					25,165	0.8% of total		
MIXED USE EFFECT									
Total Waste Heat Contribution	GJ	From Commercial				47,548			
% of total residential requirement	%					1.5%	of total		
SOLAR HOT WATER PREHEAT									
% Total Household Energy	%	Assume it meets 70% of hot water heating requirement				11.9%			
% all homes served	%	Assume it is implemented in new homes and retrofits e				25.0%			
Total heat energy savings	GJ					77,932	2.4% of total		

COMMERCIAL SCENARIOS

	units		BAU	CEP
Base Stock	sq meters		1,390,000	1,390,000
Base Energy Intensity Total	GJ/sqm		1.05	1.05
Base Energy Intensity Heat (LOAD)	GJ/sqm		0.38	0.38
Base Energy Intensity Non-Heat	GJ/sqm		0.67	0.67
Annual Increment	%		0.015	0.025
Total new commercial space	sq meters		373,890	673,463
Total commercial space	sq meters		1,763,890	2,063,463
Total Head Load	GJ		677,423	792,475
Total Non-Heat Load	GJ		1,182,803	1,383,686
Total Building Energy Commercial	GJ		1,860,226	2,176,161
PASSIVE SOLAR				
% Heating Reduction per buildings	%	Assume affects all new buildings		10.0%
Total heating energy savings	GJ			25,864
% Savings on Light	%	Assume affects all new buildings		10%
Total Non Heat Energy Savings	GJ			43,977
MICROCLIMATE				
% Heating Reduction per building	%	Assume affects all new buildings		5.0%
Total heat energy savings	GJ			12,932
MIXED USE EFFECT				
% of stock in mixed use	%	40% of office/retail/restaurant		20%
% energy available to residential sector	%			30%
Total heat energy transferred to Residential	GJ			47,548
MICROCOGEN PENETRATION				
Percent served by microcogen	%	Of all commercial buildings		15.0%
Total non heat supplied	GJ	Assume sized to meet elec needs		67,740
Heat to power ratio				1.3
Total heat supplied	GJ			88,062
Total heat used (assume 50% is usable)	GJ	Assume 50% of available is useable		44,031

BUILDINGS: ENERGY SOURCES

TOTAL BUILDINGS LOAD

	BASE		BAU		CEP	
	%	GJ	%	GJ	%	GJ
Pre-DSM Load		4,211,025		5,189,565		5,505,499
DSM Efficiency	0%	-	10.0%	518,956	20.0%	1,101,100
DSM Density	0%	-	0.0%	-	1.7%	95,322
DSM Passive Solar	0%	-	0.0%	-	2.2%	122,657
DSM Microclimate	0%	-	0.0%	-	0.7%	38,097
DSM Mixed Use	0%	-	0.0%	-	0.9%	47,548
		-		-		
Net Energy Load		4,211,025		4,670,608		4,155,755
		-		-		-
Grid Electricity	37%	1,560,535	40.5%	1,892,239	37%	1,541,831
Natural Gas	63%	2,650,490	59.5%	2,778,369	43%	1,798,310
Wood Waste DHC	0%	-	0.0%	-	11%	468,739
Micro-cogeneration	0%	-	0.0%	-	3%	111,771
Solar Hot Water		-		-	2%	77,932
Heat Pumps	0%	-	0.0%	-	4%	156,471
NET LOAD	100%	4,211,025	100.0%	4,670,608	100%	4,155,053

Efficiency Assumptions

	BASE			BAU	CEP
Grid Electricity	100%			100%	100%
Natural Gas	70%			74%	78%
Wood Waste	70%	distn losses	15.0%		
Municipal Waste	70%	distn losses	15.0%		
Micro-cogeneration	85%				
Heat Pumps	250%				

TOTAL BUILDING ENERGY CONSUMPTION

	BASE		BAU		CEP	
	%	GJ	%	GJ	%	GJ
Grid Electricity	29%	1,560,535	34%	1,892,239	31.2%	1,541,831
Natural Gas	71%	3,786,415	66%	3,754,552	46.7%	2,305,525
Wood Waste	0%	-	0%	-	14.6%	721,698
Micro-cogeneration	0%	-	0%	-	2.7%	131,495
Heat Pump	0%	-	0%	-	3.2%	156,471
Solar Hot Water	0%	-	0%	-	1.6%	77,932
TOTAL		5,346,950		5,646,792		4,934,952
Local Supply		0.0%		0.0%		22%

TRANSPORTATION and LAND USE PLANNING

	Units	BASE	BAU	CEP
# Commuters		33,760	42,841	42,841
Average Distance (1-way)	km	5.8	6.5	5.2
Total Number of Trips		16,880,000	21,420,476	21,420,476
No. of trips per household/day		7	7	7
No. of households		26,250	32,711	32,711
Total no. of trips		67,068,750	83,576,274	83,576,274
Ave distance one way	km	5.8	6.5	5.2
Annual Casual Travel	VKT/yr	772,632,000	1,086,491,568	869,193,254
Annual Transit Trips	No.	592,000		
Total Transit Distance Travelled	Km/year	854,000	963,715	3,416,000
MODAL SPLIT				
Total number of trips		84,540,750	107,280,990	107,280,990
Ave Trip length		5.8	6.5	5.2
% SOV		92%	92%	79%
% HOV		5%	5%	12%
% Transit		1%	1%	4%
% Pedestrian/Bicycle		2%	2%	5%
Energy consumption rate SOV	GJ/km	0.0040	0.0040	0.0040
Transport energy consumed SOV	GJ/year	1,797,837	2,574,529	1,762,841
Energy Consumption rate HOV	GJ/km	0.0020	0.0020	0.0020
Energy Consumption HOV	GJ/year	48,695	69,733	133,887
Energy consumption rate BUS	GJ/km	0.0025	0.0025	0.0025
Actual Distance travelled BUS	KM	854,000	963,715	3,416,000
Transport energy consumed BUS	GJ/year	14,050	15,855	59,970
SUMMARY				
Total Transport energy	GJ/yr	1,860,583	2,660,117	1,956,698
Total Per Capita	GJ/cap/year	25.8	29.1	21.4
Gasoline Share Buses	%	100%	100%	0%
Gasoline Share Autos	%	100%	100%	90%
Alternate Fuel Share Bus	%	0%	0%	100%
Alternate Fuel Share Autos	%	0%	0%	10%
Gasoline Consumption	GJ/yr	1,860,583	2,660,117	1,707,055
Alternate Fuel Consumption	GJ/yr	0.00	0.00	249,643
VKT commute + casual	km/year	459,539,169	658,066,956	469,886,445
VKT/cap	km/cap/yr	6,382	7,202	5,143
				29%
TRANSIT COST BREAKDOWN				
Total Fuel Costs	$/year	$ 252,905	$ 285,396	$ 989,506
Total Labour Costs	$/year	$ 1,810,200	$ 2,297,118	$ 7,240,800
Total Other Costs	$/year	$ 522,895	$ 663,547	$ 2,091,581
Total Cost of Transit System	$/year	$ 2,586,000	3,246,060	10,321,887
Municipal Share of Cost	$/year	0.51	0.51	0.51
Total Revenue	$/year	$ 648,000	822,004	5,049,455
Net Municipal Cost	$/year	$ 670,860	833,486	214,707

MUNICIPAL FLEET				
No. of vehicles in municipal fleet		108	108	108
Annual Fleet Travel	VKT/year	3,240,000	3,656,250	2,925,000
Gasoline Share	%	100%	100%	0%
Gasoline Energy Consumption	GJ/year	12,960	14,625	-
Alternate Fuel Share	%	0%	0%	100%
Alternate Fuel Energy Consumption	GJ/year	0	0	11,700
Fuel Cost	$/year	$ 233,280	$ 277,875	$ 193,050

INFRASTRUCTURE

Km road		626	715	626
Cost of Road Maintenance	$/yr	990,000	$ 1,130,666	$ 990,000
Cost of Road Maintenance/km	$/km	1,581	1,581	1,581
No. Parking Spaces		9,800		
# parking spaces per 1000		136	-	-
Road/1000population	km/1000	9	8	7
Cost of snow removal/street cleaning	$/yr	$ 3,000,000	$ 3,426,261	$ 3,000,000
Cost of snow removal/km road	$/km/yr	$ 4,792	$ 4,792	$ 4,792
Average Cost of Services per Hhd	$/hhd	$ 25,000	$ 27,500	$ 17,500
Total cost of servicing lots	$/yr	$ 9,843,750	$ 13,493,234	$ 8,586,604
Waste water pumping cost	$/year	$ 92,000	$ 101,200	$ 91,080
Water supply pumping costs	$/year	$ 585,000	$ 643,500	$ 579,150
Pumping Cost per housing unit	$/hhd	$ 26		
Pumping Costs Total	$/year	$ 677,000	$ 952,012	$ 761,609
Total Infrastructure Costs	$/year	$ 14,510,750	$ 18,794,861	$ 13,246,834

MUNICIPAL ACCOUNTS

		BASE	BAU	CEP
Building Energy Costs	$/year	$ 675,000	$ 573,750	$ 472,500
Fleet Fuel Costs	$/year	$ 233,280	$ 277,875	$ 193,050
Transit Costs	$/year	$ 670,860	$ 833,486	$ 214,707
Road Maintenance	$/year	$ 990,000	$ 1,130,666	$ 990,000
Street Cleaning and Snow Removal	$/yr	$ 3,000,000	$ 3,426,261	$ 3,000,000
Pumping Energy Costs	$/year	$ 677,000	$ 952,012	$ 761,609
TOTAL MUNICIPAL COST	**$/year**	**$ 6,246,140**	**$ 7,194,050**	**$ 5,631,867**

OTHER FINANCIAL EFFECTS

		BASE	BAU	CEP
Lot Servicing Cost	$/year	$ 9,843,750	$ 13,493,234	$ 8,586,604
DHC Revenue	$/year	$ -	$ -	$ 2,200,000

COSTS AND EMPLOYMENT

BUILDING ENERGY						DIRECT, INDIRECT, INDUCED			Respending Effect			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	518,956	1,404,724		$ 5,632,866	$ 11,921,671	13.6	77	162						38	81
Electricity Grid	1,892,239	1,541,831	$ 17.80	$ 33,681,861	$ 27,444,600	3.3	111	91							
Natural Gas Mains	3,754,552	2,305,525	$ 5.40	$ 20,274,583	$ 12,449,835	3.3	67	41							
Total Local Supply	-	1,009,664		$ -	$ 5,509,363	3.3	-	18						-	9
TOTAL	**6,165,748**	**6,261,745**		**$ 59,589,310**	**$ 57,325,470**		**255**	**312**	**$ 2,263,840**	**12**	**27**	**255**	**339**	**38**	**117**

TRANSPORTATION ENERGY						DIRECT, INDIRECT, INDUCED			Respending Effect			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
Gasoline	2,660,117	1,707,055	$ 18.00	$ 47,882,109	$ 30,726,992	3.30000	158	101						79	51
Alternate Fuels	-	249,643	$ 16.50	$ -	$ 4,119,107	3.30000	-	14						-	7
TOTAL	**2,660,117**	**1,956,698**		**47,882,109**	**34,846,099**		**158**	**115**	**13,036,010**	**12.0**	**156**	**158**	**271**	**79**	**214**

EMISSIONS

	BUILDING ENERGY					TOTAL CO2			TOTAL NOx		
Energy Source	BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	BASE t	BAU t	CEP t	BASE kg	BAU kg	CEP kg
DSM Total	-	518,956	1,404,724	-	-	-	-	-	-	-	-
Electricity Grid	1,560,535	1,892,239	1,541,831	0.0381	0.0108	59,514	72,164	58,801	16,854	20,436	16,652
Natural Gas Mains	2,650,490	3,754,552	2,305,525	0.0497	0.0421	131,729	186,601	114,585	111,692	158,217	97,155
Wood Waste DHC	-	-	721,698	-	-	-	-	-	-	-	-
Micro-cogeneration	-	-	131,495	0.0252	0.0263	-	-	3,307	-	-	3,463
Heat Pumps	-	-	156,471	0.0153	0.0043	-	-	2,387	-	-	676
TOTAL	**4,211,025**	**5,646,792**	**4,857,021**			**191,243**	**258,766**	**179,079**	**128,545**	**178,653**	**117,946**

	TRANSPORT ENERGY					TOTAL CO2			TOTAL NOx		
Energy Source	BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	BASE t	BAU t	CEP t	BASE kg	BAU kg	CEP kg
Gasoline	1,860,583	2,660,117	1,707,055	0.0700	0.0548	130,241	186,208	119,494	101,960	145,774	93,547
Alternate Fuel	-	-	249,643	0.0365	0.0274	-	-	9,112	-	-	6,840
TOTAL	**1,860,583**	**2,660,117**	**1,956,698**			**130,241**	**186,208**	**128,606**	**101,960**	**145,774**	**100,387**

A3.2 CITY OF CASTLEGAR

Land Use Planning

- Decrease in the average trip length from 4.1 to 3.3 kilometers.
- 30% of residential growth occurs in the downtown and neighboring areas. Overall, residential growth is accommodated in equal proportions of single family dwellings to multi-family and apartment.
- 40% of all office and retail space is in mixed use, representing roughly 15% of commercial space; 30% of heat in this space is available to the residential sector as waste heat.
- Costs of infrastructure services are reduced by 30% per lot through locating development near to central facilities, contiguous with existing development, and by including multi-family housing types in equal proportion to single family conventional and single family cluster units.

Transportation Management

- Increase in the average commuter vehicle occupancy from 1.1 to 1.3 persons per vehicle.
- All municipal and fleet vehicles, and 10% of individual vehicles are converted to alternate fuel vehicles
- The combination of transportation management and land use planing strategies allows a modal shift to occur:

Transit:	From less than 1% to 3%
Pedestrian/cycling	From less than 4% to 10%
Auto HOV	From less than 5% to 10%
Auto SOV	From more than 90% to 77%

Site and Building Design

- Availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and exiting buildings.
- All new buildings achieve savings of 15% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling, and vegetative wind shielding.
- 50% of all homes use solar hot water heaters to meet 85% of hot water heating requirements per home.

Alternative Supply

- By 2010, the district energy system meets 28% of the city's building energy needs.
- 20% of all new commercial buildings utilize distributed generation via natural gas engines with waste heat recovery.
- Heat pumps overall meet 10% of the city's building energy needs.
- The remainder is supplied by the natural gas and electric grid systems in proportions equal to those in 1994.

CITY OF CASTLEGAR

PRIMARY INDICATORS

MUNICIPAL ACCOUNTS					
Operating Expenses	$/year	$	1,604,896	$	1,227,611
Annual Infrastructure Costs	$/year	$	3,693,633	$	2,350,494
Annual Net Revenue:Municipal Utility	$/year	$	-	$	1,000,000
SOCIO-ECONOMIC					
Percentage of Energy from Local Sources	%		0%		37%
Local Employment from Energy Investments	job-years		14		51
ENVIRONMENTAL					
Total CO2 Emissions	t/year		55,519		31,598
Total NOx Emissions	t/year		38,346		20,482
ENERGY					
Total Energy Consumption	GJ/year		1,096,993		844,143
Total Annual Cost of Energy	$/year	$	14,372,123	$	11,763,077
Per Capita Annual Cost of Energy	$/cap/year	$	1,249	$	1,022

TRANSPORTATION

	Units	BASE	BAU	CEP
# Commuters		2,785	4,469	4,469
Average Distance (1-way)	km	3.9	4.1	3.3
Total number of trips	trips/yr	1,392,500	2,234,554	2,234,554
No. of trips per household/day		7	7	7
No. of households		2,790	4,477	4,477
Total no. of trips		7,128,450	11,439,070	11,439,070
Ave distance one way	km	3.9	4.1	3.3
Annual Casual Travel	VKT/yr	55,601,910	93,800,371	75,497,859
Annual Transit Trips	No.	23,000		
Total Transit Distance Travelled	Km/year	50,000	52,564	200,000
MODAL SPLIT				
Total number of trips		8,543,950	13,710,532	13,710,532
Ave Trip length		4.7	4.9	3.9
% SOV		90%	90%	77%
% HOV		5%	5%	10%
% Transit		1%	1%	3%
% Pedestrian/Bicycle		4%	4%	10%
Energy consumption rate SOV	GJ/km	0.0040	0.0040	0.0040
Transport energy consumed SOV	GJ/year	143,390	241,899	166,576
Energy Consumption rate HOV	GJ/km	0.0020	0.0020	0.0020
Energy Consumption HOV	GJ/year	3,983	6,719	10,817
Energy consumption rate BUS	GJ/km	0.0025	0.0025	0.0025
Actual Distance travelled BUS	km	50,000	80,235	200,000
Transport energy consumed BUS	GJ/year	823	1,320	3,290
SUMMARY				
Total Transport energy	GJ/yr	154,241	249,938	180,683
Total Per Capita	GJ/cap/yr	21.5	21.7	15.7
Gasoline Share Buses	%	100%	100%	0%
Gasoline Share Autos	%	100%	100%	90%
Alternate Fuel Share Bus	%	0%	0%	100%
Alternate Fuel Share Auto	%	0%	0%	10%
Gasoline Consumption	GJ/yr	148,196	249,938	159,653
Alternate Fuel Consumption	GJ/yr	0.00	0.00	21,030
VKT commute + casual	km/year	36,671,960	61,865,574	43,980,320
VKT/cap	kn/cap/yr	5,115	5,377	3,822
TRANSIT COST BREAKDOWN				
Total Fuel Costs	$/year	$ 14,807	$ 23,761	$ 54,293
Total Labour Costs	$/year	$ 141,400	$ 226,905	$ 565,600
Total Other Costs	$/year	$ 45,793	$ 73,484	$ 183,172
Total Cost of Transit System	$/year	$ 202,000	324,151	803,064
Municipal Share of Cost	$/year	0.51	0.51	0.51
Total Revenue	$/year	$ 19,900	83,038	379,603
Net Municipal Cost	$/year	$ 83,120	82,279	29,960

MUNICIPAL FLEET				
No. of vehicles in municipal fleet		43	43	43
Annual Fleet Travel	VKT/year	946,000	994,513	946,000
Gasoline Share	%	100%	100%	0%
Gasoline Consumption	GJ/year	3,784	3,978	-
Alternate Fuel Share	%	0%	0%	100%
Alternate Fuel Energy Consumption	GJ/year	-	-	3,784
Fuel Cost	$/year	$ 68,112	$ 75,583	$ 62,436

INFRASTRUCTURE

Km road		79	101	79
Cost of Road Maintenance	$/yr	640,000	$ 821,610	$ 640,000
Cost of Road Maintenance/km	$/km	8,101	8,101	8,101
No. Parking Spaces		1,800		
Street cleaning and snow removal	$/year	300,000	385,130	300,000
Cost / km road	$/km	3,797		
Average Costs of Services per Hhd	$/hhd	$ 25,000	$ 27,500	$ 17,500
Total cost of servicing lots	$/yr	$ 2,092,500	$ 3,693,633	$ 2,350,494
Pumping Cost per housing unit	$/hhd	$ 30		
Total Pumping Costs	$/year	$ 85,000	$ 143,395	$ 115,415
Total Infrastructure Costs	$/year	$ 2,817,500	$ 4,658,638	$ 3,105,909

MUNICIPAL ACCOUNTS

		BASE	BAU	CEP
Building and Street Light Energy Costs	$/year	$ 114,000	$ 96,900	$ 79,800
Fleet Transport Costs	$/year	$ 68,112	$ 75,583	$ 62,436
Transit Costs	$/year	$ 83,120	$ 82,279	$ 29,960
Road Maintenance	$/year	$ 640,000	$ 821,610	$ 640,000
Street cleaning and snow removal	$/yr	$ 300,000	$ 385,130	$ 300,000
Pumping Energy Costs	$/year	$ 85,000	$ 143,395	$ 115,415
TOTAL MUNICIPAL COST	**$/year**	**$ 1,290,232**	**$ 1,604,896**	**$ 1,227,611**

OTHER FINANCIAL EFFECTS

		BASE	BAU	CEP
Lot Servicing Cost	$/year	$ 2,092,500	$ 3,693,633	$ 2,350,494
DHC Revenue	$/year	$ -	$ -	$ 1,000,000

COSTS AND EMPLOYMENT

BUILDING ENERGY						DIRECT, INDIRECT, INDUCED			RESPENDING EFFECT			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	79,828	222,736		$ 928,990	$ 1,714,262	13.6	13	23						6	12
Electricity Grid	352,431	233,583	$ 17.80	$ 6,273,277	$ 4,157,779	3.3	21	14							
Natural Gas Mains	494,624	184,308	$ 5.40	$ 2,670,970	$ 995,265	3.3	9	3							
Local Supply Total	-	245,568		$ -	$ 1,675,025	3.3	-	6						-	3
TOTAL	**926,883**	**886,196**		**$ 9,873,237**	**$ 8,542,331**		**42**	**46**	**$ 1,330,906**	**12**	**16**	**42**	**62**	**6**	**30**

TRANSPORTATION ENERGY						DIRECT, INDIRECT, INDUCED			RESPENDING EFFECT			TOTAL			
Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Savings	Respend Multiplier	# Job-Yrs Respend	Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
Gasoline	249,938	159,653	$ 18.00	$ 4,498,886	$ 2,873,756	3.30	15	9						7	5
Alternate Fuel	-	21,030	$ 16.50	$ -	$ 346,990	3.30	-	1						-	1
TOTAL	**249,938**	**180,683**		**4,498,886**	**3,220,746**		**15**	**11**	**1,278,140**	**12.0**	**15**	**15**	**26**	**7**	**21**

EMISSIONS

	BUILDING ENERGY					TOTAL CO2			TOTAL NOx		
	BASE	BAU	CEP	CO2	NOx	BASE	BAU	CEP	BASE	BAU	CEP
Energy Source	GJ	GJ	GJ	t/GJ	kg/GJ	t	t	t	kg	kg	kg
DSM Total	-	79,828	222,736	-	-	-	-	-	-	-	-
Electricity Grid	188,238	352,431	233,583	0.0381	0.0108	7,179	13,441	8,908	2,033	3,806	2,523
Natural Gas Mains	249,576	494,624	184,308	0.0497	0.0421	12,404	24,583	9,160	10,517	20,843	7,767
DHC - wood	-	-	129,676	-	-	-	-	-	-	-	-
Solar Hot Water	-	-	26,044			-	-	-	-	-	-
DHC - gas						-	-	-	-	-	-
Microcogen comm	-	-	21,776	0.0252	0.0263	-	-	548	-	-	573
Microcogen res						-	-	-	-	-	-
Cogen sewage						-	-	-	-	-	-
Heat Pumps	-	-	68,073	0.0153	0.0043	-	-	1,038	-	-	294
TOTAL	**437,816**	**847,055**	**663,460**			**19,583**	**38,023**	**19,654**	**12,550**	**24,650**	**11,157**

	TRANSPORT ENERGY					TOTAL CO2			TOTAL NOx		
	BASE	BAU	CEP	CO2	NOx	BASE	BAU	CEP	BASE	BAU	CEP
Energy Source	GJ	GJ	GJ	t/GJ	kg/GJ	t	t	t	kg	kg	kg
Gasoline	148,196	249,938	159,653	0.0700	0.0548	10,374	17,496	11,176	8,121	13,697	8,749
Alternate Fuel	-	-	21,030	0.0365	0.0274	-	-	768	-	-	576
TOTAL	148,196	249,938	180,683			10,374	17,496	11,943	8,121	13,697	9,325

A3.3 CITY OF SURREY

Land Use Planning

- 30% of residential growth occurs in or within walking distance of the mixed use nodes. Overall, residential growth is accommodated in equal proportions of singe family dwellings to multi-family and apartments.
- Average casual and intra-city commute trip length decreases from 5.7 to 4.2 kilometers.
- 40% of all office and retail space is in mixed use; 30% of the heat used in that space is available to the residential sector as waste heat.
- Costs of infrastructure services are reduced by 30% per lot through locating development near to central facilities and employment centres, contiguous with existing development, and by including multi-family conventional and single family cluster units.

Transportation Management

- Increase in the average commuter vehicle occupancy from 1.28 to 1.4 persons per vehicle.
- All municipal and fleet vehicles and 10% of individual vehicles are converted to alternative fuel vehicles.
- The combination of transportation management and land use planning strategies allows a modal shift to occur:

Transit	From less than 5% to 10%
Pedestrian/cycling	From less than 10% to 15%
Auto HOV	From less than 13% to 20%
Auto SOV	From more than 70% to 50%

Site and Building Design

- Assume that the availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and existing buildings.
- All new buildings achieve savings of 15% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling and vegetative wind shielding.
- 50% of homes use solar hot water heaters to meet 85% of hot water heating requirements per home

Alternative Supply

- By 2010, a multi-fueled district energy system meets roughly 6% of the city's building energy needs.
- A cogeneration plan on the sewage treatment facilities provides a further 3%
- A solar photovoltaic roof-top plant meets a further 3% of energy requirements in the form of electricity.
- of all new commercial buildings utilize distributed generation via natural gas engines with waste hat recovery.
- Heat pumps, when installed, meet all the heating and cooling needs of the building with a payback of 3 to 5 years. Overall, heat pumps meet 12% of building heating requirements.
- The remainder of building energy is supplied by the natural gas and electric grid systems in proportions equal to those in 1994.

CITY OF SURREY

PRIMARY INDICATORS

			BAU		CEP
MUNICIPAL ACCOUNTS					
Selected Operating Expenses	$/year	$	29,942,268	$	17,141,368
Annual Infrastructure Costs	$/year	$	146,129,389	$	102,290,572
Annual Net Revenue:Municipal Utility	$/year	$	-	$	2,267,000
SOCIO-ECONOMIC					
Percentage of Energy from Local Sources	%		0%		33%
Local Jobs from Energy Investments	Job-Years		753		2449
ENVIRONMENTAL					
Total CO2 Emissions	t/year		3,280,184		1,897,537
Total NOx Emissions	kg/year		2,956,466		1,805,475
ENERGY					
Total Energy Consumption	GJ/year		48,645,073		34,382,037
Total Annual Cost of Energy	$/year	$	636,802,244	$	498,177,167
Per Capita Annual Cost of Energy	$/cap/year	$	1,145	$	896

TRANSPORTATION

	Units	BASE	BAU	CEP
# Commuters		114,725	232,016	232,016
Average Distance (1-way)	km	18.7	18.7	18.7
Total Number of Trips		57,362,500	116,008,208	116,008,208
No. of trips per household/day		8	8	8
No. of households		80,285	162,366	162,366
Total no. of trips		234,432,200	474,108,684	474,108,684
Ave distance one way	km	4.9	5.7	4.2
Annual Casual Travel	VKT/yr	2,316,190,136	5,404,839,000	3,982,512,947
Annual Transit Trips	No.	6,960,000		
Total Transit Distance Travelled	Km/year	9,862,000		
MODAL SPLIT				
Total number of trips		298,754,700	604,192,588	604,192,588
Ave Trip length	km	9.5	10.3	8.8
% SOV		70%	72%	50%
% HOV		13%	13%	20%
% Transit		7%	5%	15%
% Pedestrian/Bicycle		10%	10%	15%
Energy consumption rate SOV	GJ/km	0.0040	0.0040	0.0040
Transport energy consumed SOV	GJ/year	7,959,962	17,880,390	10,604,360
Energy Consumption rate HOV	GJ/km	0.0020	0.0020	0.0020
Energy Consumption HOV	GJ/year	739,139	1,614,202	2,120,872
Energy consumption rate BUS	GJ/km	0.0025	0.0025	0.0025
Actual Distance travelled BUS	KM	8,540,000	9,853,846	34,160,000
Transport energy consumed BUS	GJ/year	497,498	776,059	1,988,318
SUMMARY				
Total Transport energy	GJ/yr	9,202,644	20,270,651	14,713,550
Total Per Capita	GJ/cap/yr	33.5	36.4	26.5
Gasoline Share Buses	%	100%	100%	0%
Gasoline Share Autos	%	100%	100%	90%
Alternate Fuel Share Bus	%	0%	0%	100%
Alternate Fuel Share Auto	%	0%	0%	10%
Gasoline Consumption	GJ/yr	9,196,599	20,270,651	11,452,709
Alternate Fuel Consumption	GJ/yr	0.00	0.00	3,260,841
VKT commute + casual	km/year	2,157,718,390	4,823,980,326	3,154,797,124
VKT/capita	km/cap/year	7,846	8,674	5,673
% Reduction in per capita VKT	%			35%

MUNICIPAL FLEET				
No. of vehicles in municipal fleet		180	180	180
Annual Fleet Travel	VKT/year	3,960,000	4,569,231	3,960,000
Gasoline Share	%	75%	75%	0%
Gasoline Consumption	GJ/year	11,880	13,708	0.00
Alternate Fuel Share	%	25%	25%	100%
Alternate Fuel Consumption	GJ/year	3960.00	4569.23	15,840
Fuel Cost	$/year	$ 279,180	$ 335,838	$ 261,360

INFRASTRUCTURE

Km road		1,400	2123	1699
Road per 1000 Population		5	3.82	3.05
Cost of Road Maintenance	$/yr	3,400,000	$ 5,157,044	$ 4,125,635
Cost of Road Maintenance/km	$/km	2,429	$ 2,429	$ 2,429
Average Cost of Services per Hhd	$/year	$ 20,000	$ 20,000	$ 14,000
Total cost of servicing lots	$/yr	$ 72,256,500	$ 146,129,389	$ 102,290,572
Water and Wastewater Pumping	$/year	$ 674,000	$ 777,692	$ 573,036
Pumping Cost per housing unit	$/hhd	$ 8	$ 8	$ 6
Pumping Costs Total	$/year	$ 674,000	$ 1,499,385	$ 1,004,373
Total Infrastructure Costs	$/year	$ 76,330,500	$ 152,064,125	$ 106,989,244

MUNICIPAL ACCOUNTS

		BASE	BAU	CEP
Building Energy Costs	$/year	$ 1,000,000	$ 850,000	$ 700,000
Fleet Fuel Costs	$/year	$ 279,180	$ 335,838	$ 261,360
Road Maintenance	$/year	$ 3,400,000	$ 5,157,044	$ 4,125,635
Pumping Energy Costs	$/year	$ 674,000	$ 1,499,385	$ 1,004,373
MUNICIPAL EXPENSES	**$/year**	**$ 5,353,180**	**$ 7,842,268**	**$ 6,091,368**

OTHER FINANCIAL EFFECTS

		BASE	BAU	CEP
Lot Servicing Cost	$/year	$ 72,256,500	$ 146,129,389	$ 102,290,572
DHC Revenue	$/year	$ -	$ -	$ 2,267,000

COSTS AND EMPLOYMENT

BUILDING ENERGY Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	DIRECT, INDIRECT, INDUCED Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Respending Effect Savings	Respend Multiplier	# Job-Yrs Respend	TOTAL Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	2,571,182	8,693,658		$ 22,845,898	$ 34,918,831	13.6	311	475						155	237
Electricity Grid	7,865,999	4,814,221	$ 17.80	$ 140,014,782	$ 85,693,127	3.3	462	283							
Natural Gas Mains	20,641,410	8,364,723	$ 5.40	$ 111,463,613	$ 45,169,506	3.3	368	149							
Total Local Supply	-	6,586,073		$ -	$ 74,148,507	3.3	-	245						-	122
TOTAL	**31,078,591**	**28,458,675**		**$ 274,324,293**	**$ 239,929,971**		**1,141**	**1,151**	**$ 34,394,321**	**12**	**413**	**1,141**	**1,564**	**155**	**773**

TRANSPORTATION ENERGY Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	DIRECT, INDIRECT, INDUCED Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Respending Effect Savings	Respend Multiplier	# Job-Yrs Respend	TOTAL Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
Gasoline	20,270,651	11,452,709	$ 18.00	$ 364,871,717	$ 206,148,760	3.30000	1,204	680						602	340
Alternate Fuel	-	3,260,841	$, 16.50	$ -	$ 53,803,872	3.30000	-	178						-	89
TOTAL	**20,270,651**	**14,713,550**		**364,871,717**	**259,952,632**		**1,204**	**858**	**104,919,085**	**12.0**	**1,259**	**1,204**	**2,117**	**602**	**1,688**

EMISSIONS

Energy Source	BUILDING ENERGY BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	TOTAL CO2 BASE t	BAU t	CEP t	TOTAL NOx BASE kg	BAU kg	CEP kg
DSM Total	-	2,571,182	8,693,658	-	-	-	-	-	-	-	-
Electricity Grid	3,472,125	7,865,999	4,814,221	0.0381	0.0108	132,416	299,986	183,600	37,499	84,953	51,994
Natural Gas Mains	10,847,355	20,641,410	8,364,723	0.0497	0.0421	539,114	1,025,878	415,727	457,108	869,829	352,489
Multi-fuel DHC	-	-	1,106,147	0.0149	0.0680	-	-	16,482	-	-	75,218
Solar Hot Water			1,075,542	-	-	-	-	-	-	-	-
Solar PV			549,473	-	-	-	-	-	-	-	-
Micro-cogeneration	-	-	887,075	0.0252	0.0263	-	-	22,310	-	-	23,362
Cogeneration (Sewage)				0.0252	0.0263	-	-	-	-	-	-
Heat Pumps	-	-	2,425,986	0.0153	0.0043	-	-	37,008	-	-	10,480
TOTAL	**14,319,480**	**28,507,409**	**19,223,168**			**671,530**	**1,325,864**	**675,126**	**494,606**	**954,782**	**513,543**

Energy Source	TRANSPORT ENERGY BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	TOTAL CO2 BASE t	BAU t	CEP t	TOTAL NOx BASE kg	BAU kg	CEP kg
Gasoline	9,196,599	20,270,651	11,452,709	0.0970	0.0994	892,512	1,967,226	1,111,462	914,142	2,014,903	1,138,399
Alternate Fuel	-	-	3,260,841	0.0365	0.0497	-	-	119,021	-	-	162,064
TOTAL	**9,196,599**	**20,270,651**	**14,713,550**			**892,512**	**1,967,226**	**1,230,483**	**914,142**	**2,014,903**	**1,300,463**

A3.4 ANAHIM LAKE

Land Use Planning

- 20% of new commercial development is in mixed use; 30% of the heat used in that development is available to the residential sector as waste heat.

Site and Building Design

- Assume that the availability of information, financing and incentives results in a doubling of the penetration rate of energy efficient technologies, both in new and existing buildings.
- All new buildings achieve savings of 10% on space heat as a result of maximizing passive solar gain, and a further 5% through use of shade, wind channeling, and vegetative wind shielding.
- 50% of all homes use solar hot water heaters to meet 70% of hot water heating requirements per home.

Alternative Supply

- The micro-hydro station displaces the diesel generating station. Public education campaigns and financing and technical assistance programs succeed in holding peak load below 2000 kW and total consumption below 10,000 megawatt hours.
- 20% of all new commercial buildings utilize distributed generation via propane fueled engines with waste heat recovery. These meet their own needs for heating and exceed them for electricity.

ANAHIM LAKE

PRIMARY INDICATORS

			BAU		CEP
SOCIO-ECONOMIC					
Percentage of Energy from Local Sources	%		15%		45%
Local Jobs from Energy Investments			6		16
Per Capita Annual Cost of Energy	\$/cap/year	\$	2,407	\$	1,624
Total Annual Cost of Energy	\$/year	\$	3,104,705	\$	2,095,087
ENVIRONMENTAL					
Total CO2 Emissions	t/year		8,945		4,864
Total NOx Emissions	kg/year		11,087		9,010
ENERGY					
Total Energy Consumption	GJ/year		145,320		120,573

COSTS AND EMPLOYMENT

BUILDINGS

Energy Source	GJ BAU	GJ CEP	Cost / GJ	Total Cost BAU	Total Cost CEP	DIRECT, INDIRECT, INDUCED: Direct Multiplier	# Job-Yrs BAU	# Job-Yrs CEP	Responding Effect: Savings	Respend Multiplier	# Job-Yrs Respend	TOTAL: Total Job-Yrs BAU	Total Job-Yrs CEP	Local Job-Yrs BAU	Local Job-Yrs CEP
DSM Total	**13,049**	**29,054**		**$ 335,362**	**$ 670,724**	**13.6**	**5**	**9**						**2**	**4**
Diesel Electricity	**36,810**	**-**	**$ 47.87**	**$ 1,762,201**	**$ -**	**3.3**	**6**	**-**						**2**	**-**
Oil	**86,615**	**66,535**	**$ 9.10**	**$ 788,194**	**$ 605,468**	**3.3**	**3**	**2**						**1**	**-**
Wood	21,895	18,544	$ 10.00	$ 218,948	$ 185,436									-	-
Small Hydro	-	32,282	$ 18.31	$ -	$ 590,989									-	-
Solar Hot Water	-	3,212	$ 13.22	$ -	$ 42,469									-	-
Total Local Supply	**21,895**	**54,038**		**$ 218,948**	**$ 818,895**	**3.3**	**1**	**3**						**1**	**2**
TOTAL	**158,369**	**149,627**		**$ '3,104,705**	**$ 2,095,087**		**14**	**14**	**$ 1,009,618**	**12**	**10**	**14**	**24**	**6**	**16**

EMISSIONS

Energy Source	BUILDING ENERGY: BASE GJ	BAU GJ	CEP GJ	CO2 t/GJ	NOx kg/GJ	TOTAL CO2: BASE t	BAU t	CEP t	TOTAL NOx: BASE kg	BAU kg	CEP kg
DSM Total	-	13,147	29,250	-	-	-	-	-	-	-	-
Diesel Electricity	21,163	36,810	-	0.0710	0.0100	1,503	2,614	-	212	368	-
Oil	41,422	86,615	66,535	0.0731	0.0100	3,028	6,332	4,864	414	866	665
Wood	10,472	21,895	18,544	-	0.4500	-	-	-	4,712	9,853	8,345
Small Hydro	-	-	32,282	-	-	-	-	-	-	-	-
Solar Hot Water	-	-	-	-	-	-	-	-	-	-	-
						-	-	-	-	-	-
TOTAL	**73,057**	**145,320**	**117,361**			**4,531**	**8,945**	**4,864**	**5,338**	**11,087**	**9,010**

APPENDIX A4
Community Energy Planning Guide

Figure A1 illustrates the six major steps involved in community energy planning. Depending on the resources available, each step can be executed at various levels of complexity. The following outlines the basic objectives of each step and provides some guidelines to assist a community in conducting the most basic analysis. Although the details that follow outline only the technical requirements of a community energy plan, public involvement at all stages of the process will be key to its success.

Step 1 Identify Planning Objectives

Identify long-term community objectives (e.g., air quality, affordability, etc.) along with performance indicators. Suitable indicators are measurable, define the baseline conditions of the community, and can be tracked over time to indicate progress toward long-term objectives. Examples include net residential density, per capita vehicle kilometers travelled, air quality indices, annual expenditures on municipal and energy services, etc.. More discussion on indicators / performance targets is included in Appendix B5.

Step 2 Collect and Analyze Data

There are two types of data to collect.

Community Benchmark Data
These data establish the baseline conditions of the community and are used to set realistic performance targets for the future. The types of data required will be determined by the planning objectives and indicators established in Step 1. Examples of useful data include: population and employment growth trends by district; housing unit numbers and types by district; office, retail and service floor space by district; costs of linear infrastructure, etc..

Energy Data
Conducting an energy analysis requires an inventory of energy sources (e.g., the percentage of building energy supplied by each source); total energy use in buildings; energy use in buildings by fuel type (e.g., electricity, natural gas, other) and by sector (e.g., residential, commercial, industrial); total cost of energy use in buildings (normally available from energy utilities and/or other fuel suppliers); energy end-use consumption patterns (e.g., percentage of building energy used for end-uses such as lights, heating, ventilation, etc.); transportation energy use (e.g., total vehicle fuel consumption by fuel type; transportation modal shares (e.g., percentage of total kilometers travelled by bus, auto, etc.); total transportation energy cost; and transportation energy cost by mode.

Given the realities of limited resources, extensive data collection may not be possible. As a minimum, energy data collected should include the total quantity of energy used in the community by fuel type, the total cost of this energy, and the percentage of energy used in transportation versus buildings.

Step 3 Develop Scenarios

Establish two scenarios: a "Base case" and a "CEP Case". Base case is a composite of existing plans under consideration intended to reflect a continuation of current trends. CEP Case involves the addition of selected CEP measures and strategies designed to improve the efficiency of proposed developments. A comparison of the two plans over a fifteen to twenty year time frame provides an estimate of the savings associated with the CEP Case.

Scenario development and analysis can be done at various levels of detail. Computer assisted planning and analytical tools are available to provide detailed quantitative analysis. However, communities can do a relatively simple analysis to develop a rough estimate of the order-of-magnitude of savings expected. The following are guidelines for a preliminary analysis:

Building Energy Savings

- Forecast the number and types of housing in the Base Case and the CEP Case. The energy consumed per unit varies by housing type. This information is available from energy utilities serving your area. There will be energy savings associated with a shift to multi-unit housing types.
- Assume that increased information, financing and technical assistance will help consumers and businesses save an additional 15% on their energy consumption in the CEP Case.

Transportation Energy Savings

- Create a Base Case by identifying the most likely areas for new subdivisions and the expected number of residents in each. Divide the community as envisioned in twenty years into four to eight districts. Make a rough estimation of the number of people living in each district and the distance from the centre of the district to the nearest mixed use centre offering a diversity of services such as grocery, other retail, restaurants, personal and professional services, etc.. Calculate the weighted average distance travelled by multiplying number of people by the distance for each district and summing over all districts.
- Create a CEP Case which assumes new patterns of land use leading to a more compact and mixed use community over a twenty year period. Specifically, try to accommodate 30% of new population growth within an existing mixed use node, and the additional 70% in contiguous development (i.e., avoiding development separated by vacant land). Again, divide the community into distinct districts and calculate the weighted average distance travelled.

Local Supply

- Identify the sources of energy used today for building energy and their total cost. For a Base Case, assume energy continues to be used by each source in the same proportions and at the same real cost over the evaluation time frame.
- Identify potential local sources of energy and their unit costs. Local sources are those that require investments - both capital and operating/maintenance - to businesses located in the community or surrounding region.
- Identify the environmental characteristics of each local source including: unit emissions of carbon dioxide, nitrous oxides, and particulate; use of renewable fuel sources; land and water use compatibility; etc.. These must be compared against the characteristics of current sources during the evaluation phase.
- Estimate the percentage of building energy that could be supplied by these local sources in a CEP scenario.

Step 4 Evaluate Scenarios

The process for evaluating different scenarios depends on the objectives identified in Step 1. As communities will have multiple objectives, it will be necessary to evaluate each scenario with respect to each objective, using the indicators identified in Step 1. Then stakeholders and decision makers must make trade-offs among objectives, or generate alternative scenarios that minimize the need to trade-off. The following are some guidelines to calculating benefits associated with energy costs, infrastructure costs, air emissions and employment trends.

Calculating Energy Cost Savings
Using factors for the cost of fuel (per litre, per kilowatt-hour, etc.) and, for transportation, average litres of fuel per kilometer, calculate total expenditures on energy in the Base Case and the CEP Case. The difference is the savings associated with the CEP measures. This analysis would be enhanced by detailed data on energy end-uses, travel characteristics, vehicle types and efficiencies, and commercial and freight transport, but it nonetheless provides a starting point for policy review purposes.

Calculating Infrastructure Cost Savings
If data has been collected on the unit cost of linear infrastructure services such as water, sewer, etc., the total cost may be calculated in each scenario either based on total lineal meters of service, or lineal meters per type of development, depending on the level of detail of the base data.

Calculating Emissions
Calculate air emissions using published emission factors (e.g., tonnes per unit of energy consumed) once the amount of energy consumed by fuel type and/or by transportation mode is known.

Calculating Employment Effects

Employment effects result from two sources:

1. Direct, indirect and induced employment from investments in the energy sector.

Investments in traditional supply will not lead to local job creation unless the community is located in an energy producing region. Investments in local supply will. In BC, investments in energy supply generate roughly 3.3 jobs per million dollars invested, including direct, indirect and induced jobs. Small-scale local resources likely produce more jobs, however not all of them will be local. Using a figure of 2-3 jobs per million dollars spent on local supply is likely to yield a reasonable estimate of the local employment effects of local supply.

Investments in energy efficiency generate roughly 13.6 jobs per million dollars invested. Calculate expenditures made by the community on energy efficiency measures, then multiply those by about 13 to get the total number of jobs created. Depending on community size and location, assume that between one third and one half of these are local.

2. Respending effects resulting from saving money on energy services.

If people are not spending money on energy, they will spend it on other goods and services. Energy services have a relative low job intensity (e.g., 3 jobs per million dollars spent) as compared to the job intensity of expenditures on a typical mix of consumer goods and services (e.g., 12 jobs per million dollars spent). After calculating the total annual cost of energy services for each of the Base and CEP scenarios, the respending effect is found by multiplying the cost difference by the final demand multiplier (e.g., 12 jobs / $million saved).

Step 5 Implementation

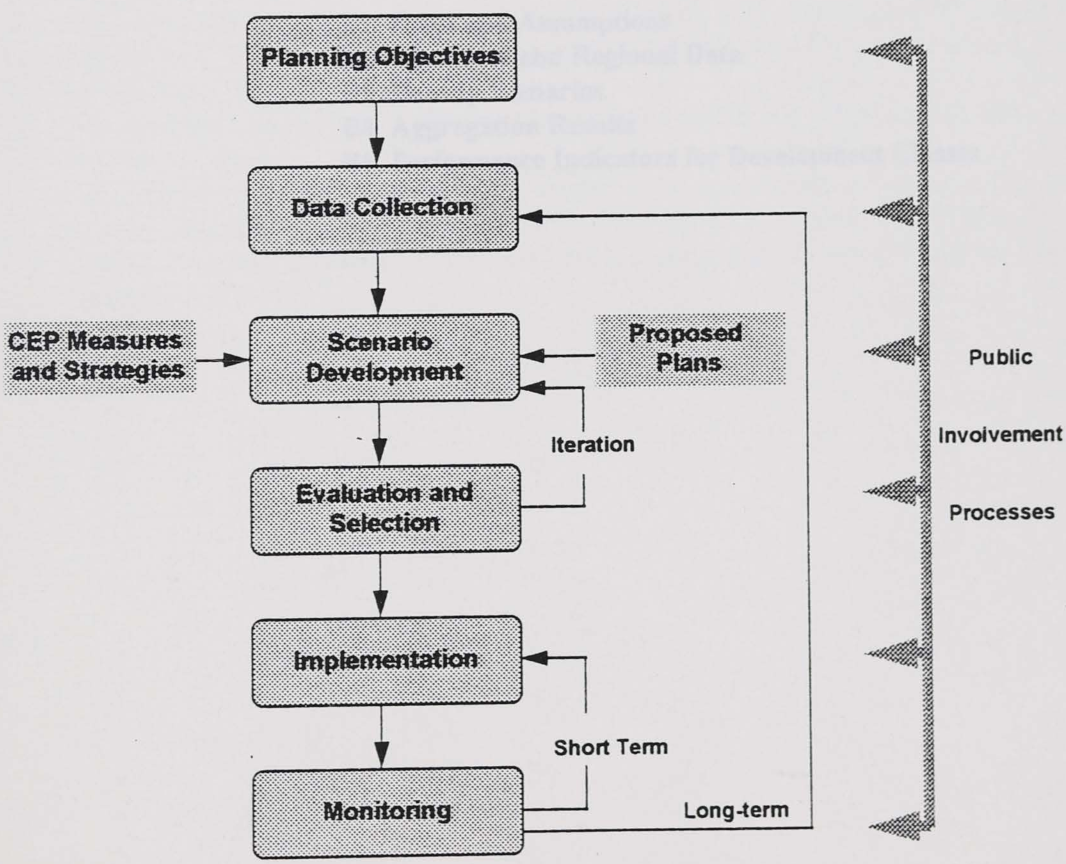
Based on the results of the first four steps of the CEP process, the community will develop an action plan for implementation. It should include a mix of instrument types (e.g., regulatory, economic incentives, information and public investment) as well as a mix of strategies from each sector (e.g., land use planning, transportation management, site and building design and alternative energy supply).

Step 6 Monitoring

Key indicators of performance are tracked over time. In the short term, monitoring results will lead to refinements to implementation strategies. In the long term, performance targets may be altered and new data requirements identified.

FIGURE A1

THE COMMUNITY ENERGY PLANNING PROCESS



APPENDIX B

MODELLING AGGREGATE EFFECTS

APPENDIX B1
Notes and Assumptions

- Per capita consumption figures are derived from the SFU Energy Research Group's 1995 study "Meeting Emission Reduction Targets in BC: Can We Do It?".
- Overall BAU emissions are calibrated with Natural Resources Canada figures and are within +/- 10%.
- Emissions from the electricity grid are calculated at 1990 levels. In reality, they should rise on a per GJ basis by 2010 due to increased percentage of electricity generated from fossil fuels. This simplifying assumption has the effect of reporting lower emissions overall, but has little effect on relative emission levels of CEP and BAU scenarios.
- Unit emissions for vehicles decrease by 25% from 1995 to 2010, reflecting a trend toward increased fuel efficiency.
- Technology and modal unit costs in 2010 are assumed equal in real terms to unit costs in 1995.
- Slight differences in the unit costs used for alternative technologies between the local and aggregate modelling exercises are the result of the time lag between the two studies. Costs used for the aggregate exercise (August 1995) reflect further refinements on the initial cost estimates used for the local case studies (October 1994).
- District heating costs are distributed on a per GJ basis over all heat and electricity output and assume that all heat and electricity produced is used.
- All buses are assumed in 1995 and 2010 to be fueled by diesel, and all autos on gasoline.
- Autos are composed of a composite of 40% fuel efficient, 40% average, and 20% vans. The definitions of "fuel efficient" etc. come from Litman (1990) at the Victoria Transport Institute and are North American figures.
- Municipal and regional data is derived from the Statistics Canada 1991 Housing and Population Census.
- Initial density conditions are based on preliminary information from interviews or GIS data from the City of Vancouver, North Vancouver City, City of Richmond, City of Burnaby and Langley Township, as well as information from the case studies in the cities of Prince George, Castlegar, and Surrey.

APPENDIX B2
Municipal and Regional Data

Regional District	Type	1991 Pop	Dwelling Units	Land Area	Gross Pop Density	Net Unit Density	Growth to 2010	2010 Pop
Vancouver	A	471,844	199,535	113	41.756	35.316	191,997	663,841
Burnaby	A	158,858	62,755	88	17.970	14.198	64,641	223,499
Victoria	A	71,228	36,295	19	37.887	38.612	22,198	93,426
Central Kootenay	A	51,073	20,215	23,237	0.022	0.017	8,208	59,281
New West	A	43,585	21,200	15	29.057	28.267	16,887	60,472
North Van City	A	38,436	18,220	11	34.942	33.127	12,516	50,952
White Rock	A	16,314	7,960	5	32.628	31.840	9,994	26,308
Esquimalt	A	16,192	6,915	7	24.167	20.642	878	17,070
Surrey	B	245,173	82,155	302	8.118	5.441	523,892	769,065
Richmond	B	126,624	44,460	124	10.212	7.171	101,088	227,712
Saanich	B	95,577	36,310	99	9.693	7.365	68,057	163,634
Port Coquitlam	B	36,773	12,110	27	13.620	8.970	52,529	89,302
Langley City	B	19,765	7,365	10	19.765	14.730	19,007	38,772
Oak Bay	B	17,815	7,660	11	16.807	14.453	3,167	20,982
Port Moody	B	17,712	6,185	23	7.701	5.378	8,711	26,423
Colwood	B	13,486	5,335	18	7.534	5.961	11,646	25,132
Sidney	B	10,082	4,455	5	20.164	17.820	5,532	15,614
Thompson-Nicola	C	104,386	39,335	44,872	0.023	0.018	34,479	138,865
RD Nanaimo	C	101,736	40,490	2,041	0.498	0.397	127,252	228,988
Fraser-Fort George	C	90,739	31,145	51,196	0.018	0.012	5,642	96,381
Dewdney-Alouette	C	89,968	30,630	3,155	0.285	0.194	150,310	240,278
Delta	C	88,978	28,825	168	5.296	3.432	46,966	135,944
Central Fraser Valley	C	87,360	29,840	385	2.269	1.550	159,944	247,304
Coquitlam	C	84,021	29,460	123	6.809	4.775	90,987	175,008
Comox-Strathcona	C	82,729	31,100	19,851	0.042	0.031	64,117	146,846
North Van DM	C	75,157	25,990	162	4.639	3.209	33,176	108,333
Fraser-Cheam	C	68,681	25,450	10,797	0.064	0.047	62,227	130,908
Okanagan-Similkameen	C	66,701	27,430	10,410	0.064	0.053	39,071	105,772
Langley DM	C	66,040	21,460	303	2.180	1.417	81,693	147,733
North Okanagan	C	61,744	23,430	7,830	0.079	0.060	35,182	96,926
Cariboo	C	61,059	21,245	69,168	0.009	0.006	6,256	67,315
Cowichan Valley	C	60,560	22,690	3,379	0.179	0.134	38,415	98,975
Peace River	C	53,317	18,585	109,540	0.005	0.003	5,245	58,562
East Kootenay	C	52,368	19,595	28,344	0.018	0.014	(2,732)	49,636
Kitimat Stikine	C	42,053	13,605	95,797	0.004	0.003	11,370	53,423
Columbia Shuswap	C	41,665	15,915	30,179	0.014	0.011	7,407	49,072
West Van	C	38,783	15,135	89	4.358	3.401	11,192	49,975
Bulkley-Nechako	C	38,000	12,630	72,101	0.005	0.004	3,430	41,430
CRD Subdivisions	C	34,488	14,865	667	0.517	0.446	32,950	67,438
Kootenay Boundary	C	31,194	12,395	7,907	0.039	0.031	3,451	34,645
Skeena-Q Charlottes	C	23,769	8,235	16,139	0.015	0.010	2,924	26,693
Squamish-Lillooet	C	23,421	8,435	16,533	0.014	0.010	41,738	65,159
Sunshine Coast	C	20,785	8,500	3,879	0.054	0.044	26,286	47,071
Powell River	C	18,477	7,225	5,101	0.036	0.028	425	18,902
Mt Waddington	C	13,896	4,885	21,464	0.006	0.005	(3,349)	10,547
Central Saanich	C	13,684	5,045	43	3.212	2.369	13,074	26,758
North Saanich	C	9,645	3,590	37	2.621	1.951	18,943	28,588
View Royal	C	5,925	2,310	11	5.436	4.239	5,698	11,623
Fort Nelson-Liard	C	5,038	1,635	82,560	0.001	0.000	(354)	4,684
University Endowment	C	4,534	1,555	14	3.239	2.221	6,279	10,813
Metchosin	C	4,232	1,390	71	0.599	0.393	2,990	7,222
Central Coast	C	3,482	1,130	25,122	0.001	0.001	1,802	5,284
GVRD Subdivision A	C	2,459	955	872	0.028	0.022	4,705	7,164
Stikine	C	2,153	820	116,143	0.000	0.000	(49)	2,104
Lions Bay	C	1,328	465	2	6.640	4.650	953	2,281
Anmore	C	741	270	5	1.482	1.080	4,228	4,969
Belcarra	C	586	210	3	1.953	1.400	164	750
TOTAL		3,126,419		880,575			2,295,433	5,421,852

Notes

1. Municipalities are represented with italics, regional districts with normal font.
2. All information is from Statistics Canada 1991 Housing and Population Census
3. Land area is all land within urban limits

APPENDIX B3
BAU and CEP Density Scenarios

BAU SCENARIO

ARCHETYPE	PROJECTED GROWTH	PORTION IN NODE		PORTION IN COMPACT		PORTION IN SPRAWL	
		%	Total	%	Total	%	Total
A	327,320	20%	65,464	40%	130,928	40%	130,928
B	793,629	5%	39,681	20%	158,726	75%	595,221
C	1,174,485	0%	-	10%	117,448	90%	1,057,036
Subtotal	2,295,433	5%	105,145	18%	407,102	78%	1,783,186
TOTAL	5,421,852	4%	221,049	18%	951,551	78%	4,249,253
TOTAL2	5,421,852	5%	273,621	20%	1,102,529	75%	4,045,702

CEP SCENARIO

ARCHETYPE	PROJECTED GROWTH	PORTION IN NODE		PORTION IN COMPACT		PORTION IN SPRAWL	
		%	Total	%	Total	%	Total
A	327,320	50%	163,660	50%	163,660	0%	-
B	793,629	30%	238,089	70%	555,540	0%	-
C	1,174,485	30%	352,345	70%	822,139	0%	-
Subtotal	2,295,433	33%	754,094	67%	1,541,339	0%	-
TOTAL	5,421,852	16%	869,997	38%	2,085,788	45%	2,466,067
TOTAL2	5,421,852	23%	1,247,044	46%	2,479,410	31%	1,695,397

TOTAL — Accounts for new growth only; i.e., assumes existing urban form remains unchanged.
TOTAL2 — Assumes that 50% of nodal growth also converts compact to nodal form, and 50% of compact growth converts sprawl to compact form.

APPENDIX B4
AGGREGATION RESULTS

SPACE HEAT: Technology Market Shares

	District Heating	Waste Heat	Micro-cogen	Nat Gas	Elec Grid
Node	20.0%	10.0%	20.0%	37.5%	12.5%
Compact	10.0%	5.0%	5.0%	60.0%	20.0%
Sprawl	2.0%	0.0%	0.0%	73.5%	24.5%

SPACE HEAT: Technology Cost Multipliers

	District Heating	Waste Heat	Micro-cogen	Nat Gas	Elec Grid
Base $/GJ	*$ 12.70*	*$ -*	*$ 9.87*	*$ 7.71*	*$ 17.80*
Node	0.7	1.0	1.0	0.7	0.7
Compact	1.0	1.0	1.0	1.0	1.0
Sprawl	1.5	1.0	1.0	1.5	1.5

Notes:

Costs represent costs to the end-use; i.e., they are adjusted for end-use efficiency

Natural gas and grid electricity are priced at prevailing utility rates adjusted for end-use efficiency.

SPACE HEAT: Technology Emission Rates

	District Heating	Waste Heat	Micro-cogen	Nat Gas	Elec Grid
tonnes/GJ	0.0360	0.0000	0.0296	0.0710	0.0544

Notes:

Emission rates are adjusted for end-use efficiency.

ELECTRICITY: Technology Market Shares

	District Heating	Micro-cogen	Nat Gas	Elec Grid
Node	20.0%	20.0%	3.0%	57.0%
Compact	10.0%	5.0%	4.3%	80.8%
Sprawl	2.0%	0.0%	4.9%	93.1%

ELECTRICITY: Technology Cost Multipliers

	District Heating	Micro-Cogen	Nat Gas	Elec Grid
Base $/GJ	*$ 12.70*	*$ 9.87*	*$ 7.71*	*$ 17.80*
Node	0.7	1.0	0.7	0.7
Compact	1.0	1.0	1.0	1.0
Sprawl	1.5	1.0	1.5	1.5

Notes:

Costs are adjusted for end-use efficiency.

Natural gas and grid electricity are priced at prevailing utility rates adjusted for end-use efficiency.

ELECTRICITY: Technology Emission Rates

	District Heating	Micro-Cogen	Nat Gas	Elec Grid
tonnes/GJ	0.0360	0.0296	0.0710	0.0381

Notes:

Emission rates are adjusted for end-use efficiency.

TRANSPORTATION: Modal Shares
% of Total Kilometers Travelled

	Transit	Van Pool	Ped	Cycle	Auto
Node	30.0%	10.0%	10.0%	10.0%	40.0%
Compact	15.0%	10.0%	5.0%	5.0%	65.0%
Sprawl	5.0%	5.0%	2.0%	2.0%	86.0%

TRANSPORTATION: Modal Cost Multipliers
$ / Passenger Kilometer Travelled

	Transit	Van Pool Passger	Ped	Cycle	Auto
Base $/pkt	*0.2480*	*0.0001*	*0.0000*	*0.0566*	*0.1520*
Node	0.7	0.7	1.0	1.0	1.0
Compact	1.0	1.0	1.0	1.0	1.0
Sprawl	2.0	1.5	1.0	1.0	1.0

Notes:

"Auto" is a composite of 40% average auto, 40% fuel-efficient auto and 20% vans

Average vehicle occupancy of autos is 1.4, of vans is 10 and of buses is 12.

Base cost includes levelized capital, operating and maintenance costs.

PKT is passenger kilometers travelled

TRANSPORTATION: Modal Emission Rates

	Transit	Van Pool	Ped	Cycle	Auto
GJ/pkt	0.0018	0.0012	0.0	0.0	0.0031
kg/GJ	71.0	97.0	0.0	0.0	97.0
kg/pkt - 1995	0.1278	0.1164	0.0000	0.0000	0.3007
kg/pkt - 2010	0.0959	0.0873	0.0000	0.0000	0.2255

Notes:

Transit cost and emission data are for diesel buses.

Auto and Van cost and emission data are for gasoline fueled vehicles.

Energy Consumption per pkt is derived from the California Energy Commission's
Energy Aware Guide, 1993.

Emission rates in 2010 are 25% lower than 1995, reflecting a shift to more fuel-efficient vehicles.

COMPOSITE UNIT COSTS

	Space Heat $/GJ	Electricity $/GJ	Transportation $/PKT
Node	7.335	11.016	0.119
Compact	9.952	16.465	0.139
Sprawl	15.428	25.805	0.157

PER CAPITA CONSUMPTION DATA

	Space Heat GJ/capita	Electricity GJ/capita	Transportation pkt/capita
Base	*45*	*20*	*20000*
Node	0.88	0.88	0.70
Compact	1.00	1.00	1.00
Sprawl	1.18	1.18	1.44

Notes:

Base consumption data are derived from Energy Research Group (1995).

PKT reductions are assumed to be proportional to VKT reductions.

TOTAL PER CAPITA COST SUMMARY

	Space Heat $/cap/year	Electricity $/cap/year	Transportation $/cap/year	Total $/cap/year
Node	$ 290	$ 194	$ 1,660	$ 2,144
Compact	$ 448	$ 329	$ 2,777	$ 3,554
Sprawl	$ 819	$ 609	$ 4,512	$ 5,940

COMPOSITE UNIT EMISSIONS - 2010

	Space Heat t/GJ	Electricity t/GJ	Transportation t/PKT
Node	0.047	0.037	0.000128
Compact	0.059	0.039	0.000170
Sprawl	0.066	0.040	0.000203

TOTAL PER CAPITA EMISSIONS SUMMARY

	Space Heat t/cap/year	Electricity t/cap/year	Transportation t/cap/year	Total t/cap/year
Node	1.84	0.65	1.79	4.28
Compact	2.64	0.78	3.39	6.81
Sprawl	3.52	0.94	5.85	10.30

SCENARIOS: BAU and CEP

POPULATION BY DEVELOPMENT CLASS IN 2010

			BAU		CEP	
	%	Initial Population	%	2010 Population	%	2010 Population
Node	4%	115,903	4%	221,049	16%	869,997
Compact	17%	544,449	18%	951,551	38%	2,085,788
Sprawl	79%	2,466,067	78%	4,249,253	45%	2,466,067

SUMMARY OF COSTS AND EMISSIONS IN 2010

			BAU		CEP		Abatement Cost
	$/cap	t/cap	$ / year (Millions)	tonnes / year	$ / year (Millions)	tonnes / year	$ / tonne
Node	$ 2,144	4.28	$ 474	946,577	$ 1,865	3,725,512	
Compact	$ 3,554	6.81	$ 3,382	6,477,063	$ 7,413	14,197,645	
Sprawl	$ 5,940	10.30	$ 25,241	43,780,464	$ 14,648	25,408,129	
Total			**$ 29,096**	**51,204,104**	**$ 23,926**	**43,331,286**	
Savings					**$ 5,170**	**7,872,819**	**$ (657)**

APPENDIX B5
Performance Indicators for Development Classes

The following indicators suggest methods of measuring neighborhood attributes that are important for establishing development classes based on CEP principles. They are adapted from Holtzclaw (1994) but may be modified to suit individual communities.

Density

At the broadest level, the total population density of communities can be measured as:

$$\text{population density} = \frac{\text{total population}}{\text{total area}}$$

This indicator is most appropriate for large metropolitan areas or regional studies looking at the macro scale. However, it will not distinguish between regions of uniform sprawl and those with nodes of compact and dense development, perhaps separated by large tracts of greenspace. The low density of the latter may in fact enhance both livability and accessibility/efficiency attributes at the neighborhood scale. Two more useful indicators of density are:

$$\text{net population density} = \frac{\text{total population}}{\text{net residential area}};$$

$$\text{net residential density} = \frac{\text{total dwelling units}}{\text{net residential area}}.$$

Unfortunately, data on net residential area are very difficult data to obtain, both in BC and across North America (Holtzclaw, 1994). Depending on the community, net residential area may comprise from 1/2 to 1/5 of total urban area. Significant judgement is required in determining which areas are to be designated residential.

Mixed Use

Mixed use does not simply refer to the extent to which people live and work within a single neighborhood. In fact, this is quite difficult to achieve. Rather, the level of mixed use should suggest the extent to which those living in a neighborhood can access essential services within their neighborhood. A useful indicator is service job density, defined as:

$$\text{service job density} = \frac{\text{number of service jobs serving local needs}}{\text{net residential area}}$$

Holtzclaw (1994) suggests a more complex indicator termed a neighborhood shopping index, which measures the fraction of the community's population which has five critical local commercial establishments within a half kilometer walking distance. Critical local services are defined as food markets, restaurants and drugstores. Supermarkets count as two establishments. Neighborhood shopping is considered a surrogate for other services; that is, the existence of these five establishments suggests that other services such as drycleaners, accountants, real estate offices, video rentals and hairstylists may also be present. All of these also represent jobs. So the neighborhood shopping index is a measure of the existence of retail and other firms, and jobs within walking distance. It is defined as:

NSI = fraction of households within 1/2 km of 5 key commercial establishments.

In the absence of operational and well-populated GIS, planners will most likely have to walk the communities under consideration in order to establish the NSI.

Pedestrian Accessibility Index

This index measures neighborhood qualitites which make a community inviting and safe to walk in. It considers continuous street grids, gentle street slopes, sidewalks, convenient building entrances, and controlled traffic. It is defined as:

PEI = (fraction of through streets)(fraction of roadway below 5% grad)(.33) x
[(fraction of blocks with walks, each side)+(building entry coefficient)+
(fraction of streets with traffic controlled)];

where

Building Entry Coefficient = 1.0 if 0-1 m setback from walk;
0.5 if 1-3 m setback from walk;
0.3 if 3-7 m setback from walk;
0.1 if 7-12 m setback from walk;
0.0 if > 12 m setback from walk.

Transit Accessibility

To measures a community's access to transit, Holtzclaw established a transit accessibility index, defined as:

$$TAI = \frac{\sum(\text{buses both directions/day})(\text{seats/bus})(\text{\%households to 1/2 km})}{(\text{50 seats / standard bus})(\text{24 hours/day})}$$

$$+ \frac{\sum(\text{railcars both directions/day})(\text{seats/car})(\text{\%households to 1 km})}{(\text{50 seats/standard bus})(\text{24 hours/day})}$$

APPENDIX C

CASE STUDY AT WESTMINSTER QUAY

C1 Technical and Cost Assumptions
C2 Next Steps for the Westminster Quay Project

APPENDIX C1

TECHNICAL AND COST ASSUMPTIONS

Data	Value	kWh	mmBTU	kW	Total
Interest Rate	8%				
Life, years	20				
Cogeneration Unit					
Electrical Capacity, kW	1,000				
Availability	98%				
Electrical Output, kwh/yr	8,584,800				
Fuel Consumption, BTU/hr	9,500,000				
Thermal Capacity, kW	1,600				
Thermal Output, kWh	13,735,680				
Stand-By Boiler					
Capacity, mmBTU/hr	2.0				
Efficiency	87%				
Energy Demands					
Estimated Thermal Energy Load, GJ	32,166				
Cogen Unit Capital Cost, $/kW	$ 1,200				
Cogen Unit Initial Investment, $	$ 1,200,000				
Back up Boiler Capital Cost, $/mmBTU/hr	$ 9,000				
Boiler Capacity, mmBTU/hr	2.00				
Boiler Initial Investment, $	$ 18,000				
Installation Costs (Piping etc for space heat)	$ 6,000,000				
Total Initial Investment, $	**$ 7,218,000**				
Avoided Cost, $/unit	$ 3,000				
Number of Units	$ 1,000				
Central Distribution Equipment and Peripherals, $	$ 1,000,000				
Total Avoided Cost, $	**$ 4,000,000**				
Net Initial Investment	**$ 3,218,000**				
Annual Costs	Rate $/...	kWh	mmBTU	kW	Total
O&M, $/kwh	$ 0.013	8,584,800			$ 111,602
Fuel, Cogen unit, $/mmBTU	$ 4.00		81,556		$ 326,222
Fuel, Boiler, $/mmBTU	$ 4.00		8,958		$ 35,832
Stand-by / Demand Charges, $/KW	$ 56.00			1,000	$ 56,000
Total Annual Costs, $/year					**$ 529,657**
Annual Revenue					
Estimated Electrical Demand, kWh	8,584,800				
Residential Electricity Rate, $/kwh	$ 0.063				
Estimated Electricity Sales, $	$ 540,842				
Avoided cost of electric heat					
Estimated space heat demand, kWh	11,427,600				
Electricity Rate ($/kWh)	$ 0.063				
Total avoided heating bill, $	$ 719,939				
Estimated Heating Revenue	$ 719,939				
Total Annual Revenue	**$ 1,260,781**				
Net Annual Cash Flow	**$ 731,124**				
Net Present Value @ 8%	**$ 3,521,690**				
Internal Rate of Return	**22%**				
Simple Payback (years)	**4.4**				

Assumptions:

The entire electrical output of the cogeneration unit is used.

A 2.0 mmBTU/hr natural gas boiler will meet peak thermal demands.

The boiler meets 20% of total thermal demand over the year.

The remaining thermal demand is met by the cogeneration unit, representing 66% of its thermal capacity.

Boiler efficiency = 87%.

The value of heat sales may rise up to the avoided cost of electric heat.

Heat provided by both boiler and cogeneration unit is saleable.

Stand-by charges are those currently proposed by BC Hydro Rate Schedule 1884 and 1885.

APPENDIX C2
Next Steps for the Westminster Quay Project

In the case of the Westminster Quay Project, the rezoning process is in its final stages and the introduction of cogeneration to the talks at this late stage is a challenge. However, there is still an opportunity for a negotiated solution. The cogeneration project outlined in this study represents a significant business opportunity, for either the developer or the municipal utility. Even in the absence of a rezoning application, multi-party negotiations - including as a minimum, the developer, the equipment supplier, the municipal utility (electrical department), BC Hydro and BC Gas - should identify a strong potential for a win-win situation. Local government has nothing to lose by initiating such a process, but much to gain. The project supports long term community sustainability objectives - both economic and environmental - and helps the municipality meet its commitments to provide innovative approaches to the provision of services and to ensure that new developments adhere to the principles of energy efficiency.

The following are suggested as a guideline for some next steps to consider with respect to the Larco development specifically:

- Form a task force to address the issue. The task force should include, at minimum, members from: New Westminster Electrical Department, City Planning Department, City Environment Committee, City Council, BC Hydro, BC Gas, the developer, and representation from the community.
- Request presentations and initial estimates from equipment suppliers on alternative technologies and their applications. As a minimum, these should include microcogeneration and water source heat pumps.
- Review the technical and cost implications on building design and construction with Larco's architects/engineers.
- Identify the environmental implications of each option, including the base "do nothing" case.
- Identify any technical concerns arising from the engineering department, the municipal utility, BC Hydro and BC Gas with respect to the potential installation.

If agreement is reached to pursue the opportunity:

- Investigate the need to renegotiate the municipal utility's purchase contract with BC Hydro to reflect the fact that the municipality may be involved in small scale distributed generation applications. Alternatively, if it is the developer who will sell the electricity, apply for exemption from the Utilities Commission Act.
- Negotiate stand-by charges with BC Hydro.
- Negotiate a bulk gas rate with BC Gas.
- Issue a Request for Proposals for energy systems including, at minimum, microcogeneration and heat pump technologies.

If no agreement is reached:

- Establish a review process within the Environment Committee to review the impact of new developments having significant energy requirements.
- Investigate the possibility of increasing utility hook-up fees for the use of electrical resistance heaters in new development.
- Investigate the possibility of introducing the requirement for energy efficient design into the final stages of the rezoning negotiations.